This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 1,069,994

THE UNIVERSITY OF MICHIGAN
LIBRARIES
THE UNIVERSITY OF MICHIGAN
1817

TRANSACTIONS

OF THE

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

VOL. IX. PART I.

PLYMOUTH:
WILLIAM BRENDON AND SON, PRINTERS,
GEORGE STREET.

TRANSACTIONS

OF THE

Royal Geological Society

OF

CORNWALL.

INSTITUTED FEBRUARY 11th, 1814.

VOLUME THE NINTH—PART THE FIRST.

"A knowledge of our subterranean wealth would be the means of furnishing greater opulence to the country than the acquisition of the mines of Mexico and Peru."

President of the Board of Agriculture.

PENZANCE:
SOLD AT THE APARTMENTS OF THE SOCIETY.
1875.

QE
262
C8
A2
v.4
1875-77

TABLE OF CONTENTS.

ERRATA.

Page vi., line 23, for "*u*" read "*a*" in Hulamanning.
Page 3, line 25, for "*on*" read "*or*."
Page 17, line 5, for "*oride*" read "*oxide of tin.*"
Page 25. line 21, for "*Crystallyanic*" read "*Crystallogenic.*"
Page 38, line 5, for "*Smith*" read "*Smyth.*"
Page 42, line 7, for "*ruggy*" read "*vuggy.*"
Page 47, line 5, for "*—nagian*" read "*—magian.*"
Page 53, line 5 & 7, for "*Ethridge*" read "*Etheridge.*"
Page 54, line 11, *ditto.* *ditto.*
Page 59, line 11, for "*its*" read "*it.*"
Page 60, line 2, for "*Kranbat*" read "*Kraubat.*"
Page 60, line 2, for "*Strub*" read "*Hrub.*"
Page 63, line 5 from below, for "*dampfrnehl*" read "*Dampfmehl.*"

On the Occurrence of Metallic Ores with Garnet Rock. Note illustrating a series of Copper Ores from Belstone Consols, Devon. By Warington W. Smyth, M.A., F.R.S., F.G.S. . . 38

VII.

On some Fossils from Mount Lebanon. By Alfred Lloyd Fox . 46

VIII.

Remarks (with a list) on some of the Organic Remains of Cornwall in the Museum of the Royal Geological Society of Cornwall at Penzance. By C. W. Peach 49

QE
262
C8
A2
v.4
1875-77

TABLE OF CONTENTS.

I.

PAGE

On Transition and Metamorphosis of Rocks in the Land's End District. By Miss Elizabeth T. Carne 1

II.

A Contribution to the Theory of Mineral Veins. By Robert Hunt, F.R.S. 22

III.

On Tooth and Fragments of Bones of Hippopotamus, from the neighbourhood of Constantine, in Algeria. By Charles Fox . 26

IV.

On the Fossil Fish of Cornwall. By Charles W. Peach, A.L.S. . 31

V.

Notice of an Accumulation of Carburetted Hydrogen, or "Fire Damp," in the Ding Dong Mine, situated in the parish of Madron, near Penzance. By Samuel Higgs, jun., F.G.S., &c. . 34

VI.

On the Occurrence of Metallic Ores with Garnet Rock. Note illustrating a series of Copper Ores from Belstone Consols, Devon. By Warington W. Smyth, M.A., F.R.S., F.G.S. . . 38

VII.

On some Fossils from Mount Lebanon. By Alfred Lloyd Fox . 46

VIII.

Remarks (with a list) on some of the Organic Remains of Cornwall in the Museum of the Royal Geological Society of Cornwall at Penzance. By C. W. Peach 49

IX.

PAGE

On the Discovery of Organic Remains in the Rocks of Nelly's Cove, near Porthalla, and of some curious Organic-like Masses in a quarry near Hayle. By C. W. Peach 55

X.

Some Observations on the Magnesite of Silesia. By Lovell Squire, jun., B.A. 59

XI.

The Geology of Lundy Island, with Map. By Nicholas Whitley. 71

XII.

Remarkable Sea Waves, observed in Mount's Bay, Cornwall, April 24th, 1868. By John Jope Rogers 74

XIII.

Notes on the Quartz Reefs or Lodes of Sandhurst, Victoria, Australia. By W. Nicholas 78

XIV.

Memorandum on the Discovery of Hazel-nuts in Tin Stream at St. Hilary. By Thomas Cornish 98

XV.

Note on Chrome Iron in the Serpentine of the Lizard. By Richard Pearce, F.G.S. 99

XVI.

Note on a Granite Block at Hulamanning. By Richard James . 101

XVII.

Memorandum on Pitchblende in Colorado. By Richard Pearce . 102

XVIII.

Note on Pitchblende in Cornwall. By Richard Pearce . . 103

XIX.

On Traces of Glacial Action on the Great Cairn, near Gorran Haven, Cornwall. By C. W. Peach 105

XX.

The Geology of Penzance Bay and its Shores, with Map. By Nicholas Whitley 109

XXI.

PAGE

On the Bones of a Whale found at Pentuan, now in the Museum of the Royal Geological Society of Cornwall. By William Henry Flower, F.R.S., &c. 114

XXII.

Some Remarks on the Mining District of Yorke's Peninsula, South Australia. By Samuel Higgs, jun. 122

XXIII.

Enquiry into the Nature of the Forces that have acted on the Formation and Elevation of the Land's End Granite. By Miss Elizabeth T. Carne 132

XXIV.

Remarks on the Lode at Wheal Mary Ann, Menheniot, with Diagrams. By Clement Le Neve Foster, B.A., D.SC., F.G.S. . 152

XXV.

Notice of a Vugh in St. Ives Consols Mines. By Captain John Gilbert 158

XXVI.

Notice on Mount Bischoff, Tasmania. By William Wellington . 161

XXVII.

On the Place and Mode of Occurrence of the Mineral Andrewsite. By C. Le Neve Foster 163

ON

TRANSITION AND METAMORPHOSIS OF ROCKS IN THE LAND'S END DISTRICT.

By Miss Elizabeth T. Carne.

Before we notice the transitions by which all these rocks are connected with one another, it may be well to point out the distinguishing features of the rocks themselves. Amidst much subordinate variety, there are five well-marked formations in our western district—a district which we will define by drawing a line from Hayle to Marazion.

1st. Granite.

2nd. Hornblende and actinolite rock, and greenstone. These vary but little in their composition; but they have two distinct types in external character. Any one walking through the fields from Paul to Newlyn Cliff may notice large blocks of hard, heavy, dark-coloured stone in the hedges, which on fracture show a peculiar glistening surface of a greenish-black colour. This is hornblende rock. A broad band of it runs from Mousehole and Penlee Point northward to Paul Hill, and it is almost the only place where it

is found south of the granite, though it is not unfrequent in St. Just, Zennor, and St. Ives.*

The more common greenstone is the hard blue stone generally used to mend our roads. It is well marked in Lariggan rocks, in the larger masses near the gas-works, in the foundation of Chyandour, in the quarry up the Coombe Lane, at Tolcarn and Gulval Carn. It is said to be a compound of hornblende and felspar; but in this district the hornblende is often mixed with or superseded by actinolite, and the felspar by axinite.†

3rd. Purple killas. This is a rock hard to describe, yet very strongly marked by its pinkish-purple tint. It is sometimes compact and hard; sometimes laminated, splitting like clay-slate; sometimes spotted with dull dark spots; but these varieties pass so readily into each other as to be easily traced. The harbour at Newlyn is full of beds of this rock, and the southern jetty there is built on it. It also forms the old quarry just opposite Newlyn Church, and occurs in patches on the rocks between Newlyn and Penlee Point.‡

4th. A felspathic rock, varying so widely that it can only be described as possessing a large excess of felspar. This rock extends several hundred yards along the shore beyond the southern jetty at Newlyn in soft and hard, light and dark varieties, inextricably

* This is the hornblende rock of Dr. Forbes, the greenstone of Dr. Boase.—*Geol. Trans. of Cornwall*, vol. ii. 251; vol. iv. 393–403.

† This is the greenstone of Dr. Forbes, the greenstone and actinolite-rock of Dr. Boase.

‡ This is the slaty-felspar of Dr. Forbes, the cornubeanite of Dr. Boase.

mixed with purple killas, actinolite, &c. Another form of felspathic rock is found in the so-called elvan-course at Polmenor, which lies open in a pit by the roadside near the farm-house. A third form, massive and very hard, is to be seen in the elvan-course that runs through the Chimney Rock.*

5th. Finally, there is a well-marked rock which, as its two varieties may be best studied in the cliffs beyond the Lelant ferry, I will call the Lelant rock. I do not know its boundary northward; but I have a specimen from St. Ives Island and St. Ives Consols Mine. At Porthminster Point (south of St. Ives) it forms the upper part of the cliffs, and further south, beyond Carrickgladden, the whole of them, extending to Lelant village, and across the water to Phillack Towans and to Hayle Foundry and railway cuttings. It is found at Crowlas railway cutting; also in an excavation for building formerly made near Marazion turnpike, and on the sea-shore east of Marazion. I presume, therefore, that it stretches across the country from St. Ives to Marazion, constituting the unaltered Devonian beds of the Ordnance map. In structure it is evidently sedimentary, occurring at Lelant in layers on beds varying in thickness from

* This formation is, I presume, the felsparite of Dr. Boase, the compact felspar of Dr. Forbes. *Geol. Trans. of Cornwall*, iv. 375; ii. 251. I was for a long time greatly perplexed and misled by Dr. Forbes' statement that slaty-felspar is "a rock apparently of the same composition as compact felspar, or only with the addition of a very small portion of mica, with a distinct slaty structure." I do not doubt that purple killas and felsparite are closely connected; but they are not "apparently so." The appearance of the two rocks is widely different; and until I met with the intermediate forms I could never identify Dr. Forbes' slaty-felspar.

an inch to a couple of feet, dipping to the S.E., and often regularly alternate in coarse and fine grain. The coarse-grained is compact, granular, of a greenish-grey colour, sprinkled with minute white specks, which give it a pepper-and-salt aspect. The fine-grained is sometimes a dull grey slate, or a glossy grey shale; indeed the colour of the coarse beds is often blue-grey when freshly cut; but the prevailing tint is a dirty greenish-grey. In many places, where the alternate beds are not to be traced, the deposit seems to be a mixture of both, having a fine grain and a greenish-grey tint. The granular pepper-and-salt aspect of the coarser beds is very peculiar, and in its frequent conjunction with the fine-grained slate or shale enables us to trace and identify the rock in various localities. The softer beds underlie great part of Penzance, and extend on the shore as far west as the Wherry Rocks; and inland, the dull greenish-grey variety and the glossy shale were both visible in the town-cuttings on York Hill. It is, I think, indisputable that these coarse and fine-grained beds are due either to separate depositions by water, or to mere settlement in water. A piece of dried mud which I took from a pool in the Hayle quarry showed the coarse grain and greenish colour at the bottom, and the fine grain and greyish colour at the top.*

This undeniably sedimentary rock supplies me

* I cannot identify this formation with any of the definitions of Dr. Forbes or Dr. Boase. No doubt its laminated fine-grained beds might be called clay-slate; but that term could not be applied to the whole deposit.

with the first link in the chain of transition. I am prepared to show, 1st, That its softer beds, which we may call clay-slate, pass into hard quartzose clay-slate, and more rarely into purple killas and into greenstone; that its glossy shale passes into purple killas; that its intermediate variety also passes into purple killas; and that its coarser beds pass, either by a mixture of actinolite into a sort of greenstone, as at Marazion, or into a hardened felspathic rock closely allied to certain elvan-courses, and to mixed masses of felsparite which border on granite.

2nd, I shall show that elvans and felsparite pass into purple killas on one hand, and into massive felspar on the other.

3rd, That purple killas passes into axinitic greenstone and into hornblende rock; but not, I think, into the coarse felspathic greenstone of the Marazion rocks.

4th, That links may be found between felspathic greenstone and granite; but not, I think, between axinitic greenstone and granite.

As these facts can only be established by long details connected with the examination of numerous specimens, we need not detain the meeting by the several proofs, but proceed to notice the manner in which these transitions have been effected, and the forces which may have been instrumental in producing them.

(i) Transition in structure.

(ii) Transition in substance.

(iii) Connection if not transition shown by alternate courses or beds.

(iv) A union of complete transition and sharp separation.

(i) Transitions in structure. There are schistose forms of granitic and hornblendic rocks, so too there is a schistose as well as a compact form of our own purple killas. This being so, there seems no reason why the laminated Lelant rock as it becomes purple killas in substance should not become schistose purple killas in structure; but as a rule it does not: its tendency is to become a tough compact purple killas, which does not break readily in the direction of the surface planes. Further, there seems no reason why schistose purple killas, as it becomes more hornblendic or feldspathic in composition, should not retain its slaty structure, and become hornblende slate or gneiss; but as a fact it does not: it becomes more massive in structure, as its substance is pervaded by hornblende or felspar. All changes in the composition of rocks seem to be accompanied in this district by a change in structure from the schistose to the massive.

Further, transition is sometimes implied by identity of structure amidst change of substance. It is curious to see in the St. Ives cliffs how completely the weathering and general aspect of the Lelant rock are preserved, when the hammer reveals the substance of the purple killas. In many places the surface is honeycombed and disintegrated in a manner which does not belong to ordinary purple killas, but which *does* belong to the softer Lelant rock. I do not know how to explain this, except by the sup-

position that the Lelant rock has really *become* purple killas. In the same way the purple killas at Mousehole, at its junction with the granite, so retains its external aspect and its dark weathering that even an uninstructed eye can in many places trace the sharp line of junction, while the hammer shows that felspar is largely mingled with the killas, oftenest in the plains of lamination, producing spotted purple killas, but sometimes destroying the schistose structure and forming massive felsparite. We can hardly doubt that this mixed rock, which still retains the external aspect of the killas, has been subsequently modified and *become* felsparite.

(ii) Next as to transition in substance. Its most complete form is that in which the very substance of two different rocks may be seen interpenetrating each other, even in a hand specimen. Clay-slate and purple killas at the Wherry rocks—Lelant rock and purple killas in the St. Ives cliffs—felsparite and purple killas at Polmenor and Newlyn—greenstone and purple killas everywhere, meet in this particular mode. It does not in itself prove that the one rock *becomes* another, for it may result equally from a mixture of original elements, or from two separate masses having been forced together while in a soft pasty state.

Another form is, when two rocks are so intermingled that the substance of one retains the grain of the other, as the purple killas at Carrickgladden Point retains the glossy grain of the Lelant shale. In this case the shale has manifestly *become* purple killas.

Another form is when one substance pervades another through a series of minute cross-joints. Nothing is more common than to see actinolite thus invading purple killas; so that in a hand-specimen, whilst the fractures in one direction show the grain of the purple killas, every fracture in the other direction reveals the actinolite. In both this and the former case some law of crystallization seems evident, which acts *across* the grain of the original rock, instead of penetrating *through* it as the easiest entrance.

It is a more doubtful case of transition when isolated veins or bunches of one substance are found in another. In a hand-specimen we may find a spot of purple killas, or of something like greenstone in the very centre of a piece of Lelant rock; or bunches of actinolite beginning and ending in a bit of purple killas. And we are told that the same thing happens on the large scale, and that masses of granite are found completely isolated in slate.* These facts are not perplexing if both rocks are assumed to be of contemporaneous origin, but it is hard to understand how a solitary piece of rock could be metamorphosed and *re*formed while all its surroundings remained unchanged. Doubtless, if isolated decomposition begins, isolated *re*formation may follow it; nevertheless, I think we must admit that this class of facts is more in harmony with a theory of original chemical affinities than with that of subsequent metamorphic action.

* *Geol. Trans. of Cornwall*, vol. v. p. 157; *Prim. Geol.*, p. 144.

(iii) Connection, if not transition, is manifested in alternate courses and beds of rock. By courses I mean bands of rock divided by joints more or less vertical, and which in this neighbourhood, according to my experience, run from N.W. or N.N.W. to S.E. or S.S.E. An instance of the alternation of soft and hard courses occurred lately in the cutting for the new St. Just road near Tregavara Lane. At the northern extremity of the cutting there was a mass of hardened purple killas mixed with actinolite, then came a block of white axinitic rock allied to greenstone, then rotten ground, then a band of white rock much decomposed, then rotten ground, then a band of greenstone much decomposed and blackened, then rotten ground, then another black band, then a long piece of rotten ground, then a quartz vein, and on the other side of it lamellar clay slate, or purple killas. The same alternation of hard and soft courses was shown in the cutting at Leskinnack Gate. These facts remind us of the alleged alternations between granite and slate, and seem to imply some law of structure at present unknown.

Of alternation in beds, the Gurnard's Head is an admirable instance. The plate which accompanies Dr. Forbes' account of that promontory* gives little idea of the twelve or fifteen narrow beds of schistose purple killas which regularly cap the upright masses and shattered terraces of more crystalline rock. And the terminal mass, which is marked hornblende rock in the plate, is itself built up by beds of greenstone

* *Geol. Trans. of Cornwall*, vol. ii.

with intervening stripes of purple killas. That terminal mass is held by some theorists to be a bed or series of beds of submarine lava intermingled with the stratified mud of the sea-bottom; and a vein of so-called hornstone is triumphantly claimed as a proof of collision between igneous and aqueous forces. As a matter of fact, there are perhaps twenty places where beds of greenstone and purple killas come in contact, and there are but two or three where this hornstone is found; moreover, it is found with purple killas above as well as below, and with greenstone below as well as above, though sometimes it runs on a line of well-marked contact between the two rocks. The so-called hornstone I believe to be nothing but a vein of massive and somewhat impure axinite, a mineral very common in all our western greenstone. The union of these two rocks, I hold to be, not accidental, as by the intrusion of lava, but structural; that is to say, it is part of the structure of the whole mass, the beds of crystalline greenstone and the beds of schistose killas that cap them being as much one rock as the fine mud of an estuary and the coarse sand beneath it are one aqueous deposit, as the scoriaceous surface bed and the basalt pillars beneath it, are one lava stream. In confirmation of this I would point out the regularity of the alternation on the western side of the Head, also the identity of structure which runs through the whole promontory, the tilted edges of the beds dipping harmoniously N.N.W., while all the surface planes dip towards the north-east. We can find hard horn-

blende rock on the western faces of the terminal back-bone and head, and well-marked layers of purple killas between them; but if we go round the northern side, and climb down the eastern descent, the whole mass becomes more schistose, and the two rocks are mixed together in shallow irregular layers. The whole mass is plainly under the same law of structure; but on the west we have the uptilted edges of the deeper beds, where structure is best developed, and on the east we have the surface planes, where structure is worst developed.

Whether this common structure is one of original formation or of subsequent metamorphosis is another question; but all facts on both sides should be fairly stated. On one hand, I was certainly surprised to find on the great bed of purple killas which underlies the grassy slope of the promontory, weather-stains and eroded surfaces, and white lines of deposition, which much resembled those of the Lelant rock. Moreover, these white lines certainly do become harder in the more compact purple killas, and seem to point onwards to other and more crystalline white lines near the hornblende rocks, and finally to the so-called hornstone or axinitic veins. On the other hand, the very substance of the purple killas is often so intimately but confusedly mingled with that of the greenstone as to forbid the idea that the one could have been metamorphosed while the other remained unchanged. And this brings me to my fourth division.

(iv) Gradual transition is in some rocks united with

sharp separation. For instance, if clear division and alternation between purple killas and greenstone is so frequent at the Gurnard's Head, gradual transition and complete intermixture are also frequent there, proving that if there be a regular structural connection between the two rocks, it is a regularity very easily disturbed. The same thing was evident in the little quarry lately opened opposite Alverton Gate, from which I have a series of specimens, showing both a gradual transition and sharp separation. It resembled the Gurnard's Head also in its prevalent joints and courses, running N.N.W. and S.S.E. It had, moreover, a partial alternation of the two rocks cut off by the occurrence of the joints. And in the fresh fractures of the quarried blocks the wavy lines and smooth greasy texture of the killas appeared confusedly mixed together with a coarse-grained mixture of axinite and actinolite, as though there had been an imperfect mixture of original materials, the large grain of the latter rocks wanting the pasty matter of the killas to form our usual compact homogeneous greenstone.

The same union of gradual transition and sharp separation may be seen in the mixed felsparite and killas of the sea rocks between Newlyn and Mousehole. Every shade of gradual transition is there, and yet in a hand-specimen they will be sometimes sharply separated. There are no regular beds or courses of rock, no systematic tendency anywhere towards transition, but felsparite and killas, and intermediate varieties, are all mixed together in stripes

and patches and shapeless blocks in the most complete confusion.

The same union of gradual transition and sharp separation is found in the junctions of granite and killas; in one place gradual transition, in another sharp separation, but in either case there is a certain relation between the two rocks. Dr. Boase distinctly tells us, that not only in Cornwall, but throughout great part of Europe, any special characteristic of a mass of granite is shared by the rocks around it.*

In all these instances we have the relation and transition which belong to laws and affinities, and also the confused irregular mixture produced by the rough action of mechanical forces.

As to the nature of these forces, I venture briefly to suggest my own conviction, that the force which elevated the rocks of this district was not simply elevatory but undulatory, and that it acted as the ocean acts on a line of cliffs, not by a dead weight of water, but by the impetus of a million successive waves. Even now earthquakes are known to act in undulations, and we speak of an 'earthquake wave' as familiarly as of an ocean wave.

An undulatory force would have two effects: it would produce a stretching out or rolling of beds so far as there was any room for free action in a horizontal direction; and it would produce lines of tension and fracture at right angles to its course. We see both these effects in our bay in a storm; the undulations come rolling in from the Atlantic, produc-

* *Primary Geology* p. 206–8.

ing lines of breakers at right angles to their course, and stretching out sheets of foaming water on the surface of the sea. So, if we look at a geological map of our own county, we see lines of greenstone and elvan running S.W. and N.E., whilst the quarry courses of which I have already spoken run at right angles from N.W. to S.E., in strict conformity with the lines of our western valleys, which, as Mr. Whitley has shown us,* generally follow this direction. So also the horizontal joints and beds of surface granite, the occasional schistose structure of greenstone, the lamination of purple killas, and the apparent stretching of the spotted purple killas, might all be due to a lateral motion imparted by an undulatory force to a pasty mass.

The occasional prevalence of the undulatory over the elevatory force might also explain why various kinds of unstratified rocks have (to use Phillips's phrase) "their stratified analogues" in some districts and not in others. If the constituents of granite or greenstone were rolled out instead of being allowed to settle and coalesce under steady pressure, it is very possible that they would take the forms of gneiss and hornblende slate.

Another force, that of gravitation, manifests itself in aqueous deposits by separating and settling the finer and coarser particles. In connection with this we must remember Mr. Scrope's opinion (now received by many), that if lava be under pressure which forbids the formation of steam, it may be loaded with

* *Geol. Trans. of Cornwall*, vol. vii. p. 350.

water, and be in the state of red-hot mud. The question then occurs whether the force of gravitation (acting conjointly with chemical affinities as the whole mass cooled and set) might not cause a settlement of the fiery mud, tending to produce an alternation of fine and coarse-grained beds when the process was undisturbed, and an irregular mixture of fine and coarse materials if the unquiet fire-sea was agitated.

The union of chemical and mechanical forces gives a wider variety of result. Take, for instance, that curious law by virtue of which crystallization comes into play at right angles to surface planes. The most familiar illustration of this is found in basalt. In a horizontal stream of basalt, the crystals, or as we commonly call them, the pillars, are perpendicular, but in a vertical dyke of basalt the crystals are horizontal. Are there not glimmerings of the existence of some such law in the transitions which occur among our primary rocks? Purple killas forms *across* the grain of the glossy shale; actinolite and hornblende creep in through minute veins in *cross* directions to the grain of the purple killas; and so perhaps, on the large scale, the forces which have produced alternate hard and soft courses, have come into play on N.W. and S.E. lines at right angles to the direction of the bands of greenstone.

Chemical affinities also have doubtless a powerful influence in effecting transitions. The great difference between granitic and hornblendic rocks is, first, a larger proportion of silica and alumina in the

granite; but, secondly, the presence of potash or soda in granite, and of lime, magnesia, and oxides of iron and manganese in hornblende. Now, these minerals—potash, soda, lime, magnesia, and the protoxides of iron and manganese—are isomorphous; alumina and peroxide of iron are isomorphous; that is, they have "the power of replacing each other without producing any noticeable change of form in the crystal of the mineral."* It appears, then, that one great difference between felspathic and hornblendic rocks consists in the presence of minerals which have special facility in replacing each other. Naturally this would seem a fruitful source of transition in rocks. Greenstone itself is an illustration of this. It is said to be a mixture of felspar and hornblende; but in Durocher's analyses given by Jukes,† the greenstone has less potash than the felspar would have supplied, less magnesia than the hornblende would have supplied; but it has a large excess of the oxides of iron and manganese. The latter minerals seem to have replaced the former. So with regard to the axinite which abounds in our western greenstone. It seems as if part of the alumina which would have formed the felspar had united with some lime and oxides of iron and manganese supplied by the hornblende, and so had formed massive axinite in the place of felspar. This facility of replacement probably explains why hornblende so readily penetrates and absorbs crystals of felspar, as it does in the

* JUKES' *Manual of Geology*, p. 24.
† *Manual of Geology*, p. 75.

Round Rock and the Wolf Rock; indeed felspar crystals appear to me in a very unstable condition, peculiarly liable to be invaded and absorbed by other minerals—by oxide often, as we all know, and here by hornblende and by chlorite, as I have noticed in vein stones in the Liskeard district; they also gradually disappear in the massive felspar Polmenor elvanstone. The metamorphic theory assumes that there is a reconstructive action continually tending towards granite as a final form; but the foregoing facts incline me to doubt whether hornblende is not the stronger and more permanent form of the two.

To conclude; many of the facts connected with transition amply prove the existence of metamorphism; in other words, that some rocks actually change into other rocks; nevertheless I have not been able to discover any trace of a regular order or system of metamorphism. That granite is brought by degradation to the state of sand and mud, that these are changed by heat and pressure into sandstone and slate, and then by further heat and pressure restored to the state of quartz, rock, and granite, is a theory far too narrow to include all the facts of our own limited districts. Several objections occur. In the first place, how are we to account for the fact that the very same rocks which sometimes pass into each other by gradual transition, are at other times sharply separated? Thus near Porthminster Point the Lelant rock lies upon, and is clearly separated from, the purple killas by a series of quartz veins. Thus in many places the granite is sharply distinct from the

killas. It is hard to account for this by any theory of metamorphosis.

Again, the confused irregular intermixture which sometimes takes place between two rocks, as between felsparite and purple killas, and purple killas and greenstone, makes it difficult to believe that the one has been altered while the other remains unchanged.

Again, there are the narrow limits to which transition is sometimes confined. When granite and killas meet, though the general disturbance of one or both may extend far beyond a few feet, it is no less true that often, within a few feet of the junction, perfect specimens of each rock may be found. Now, when we consider the strength of the forces necessary to manufacture miles of granite out of killas, it is but reasonable to suppose that they would have at least partially altered a wide tract of intervening rock. It is difficult to conceive how they could have failed to do this, if they were forces potent enough to transform one rock into such huge masses of the other.

Again, there is the strong argument derived from change of structure. As I have noticed before, the transitions in the substance of our rocks are accompanied by transitions in structure—internally from the laminated to the crystalline, externally from the schistose to the massive. Slow heat under pressure is known to produce these changes; and as slow heat under pressure is the chief agent invoked by the theory of metamorphism, we have some right to conclude that the laminated structure would be destroyed in the process of transition; yet hornblende slate

and gneiss are well-known forms, highly laminated, and said to be highly metamorphic.

Again, it must be remembered, that the fact of transition is in itself no proof of systematic metamorphism, since it belongs equally to rocks that must have had different origins. The limestone of Glen Tilt becomes silicious at its junction with granite, but no one thence argues that it is the ultimate destiny of limestone to become granite, or that granite once was limestone.

In short, the whole result of my investigations presents a singular anomaly between theory and facts. According to facts, it is comparatively easy to establish a series of transitions between the sedimentary felspathic Lelant rock and greenstone; but not so easy to establish such a series between that rock and granite—elvan-courses being the principal link. According to the theory of metamorphism, the case should have been reversed. The felspathic sedimentary rock should have passed onward readily into crystalline granite, and only have tended towards greenstone by the side introduction of hornblende. At present I can only regard granite as a somewhat isolated rock, connected with others by chemical affinity rather than by manifest transition. Perhaps the felstone of Ireland, and the hornblendic granite of Scotland, may supply links in transition which are wanting in Cornwall.

The introduction of hornblende and other minerals forms another objection to the theory of metamorphism. Where do its lime, iron, and magnesia come

from? They at least are simple elements, which must have had some origin independent of metamorphism. Again, where does the alkali of our granite and its surrounding killas come from? Dr. Boase has already pointed out that it is not found in later deposits.* Again, where do the metals of our mineral veins come from? Either they are a new introduction, or they existed in former sedimentary rocks as the waste of still earlier metallic deposits. But, in that case, would they not have taken the form of horizontal beds, like our own stream-tin and the iron-stone of the coal fields? If all these new elements have existed outside of the assumed circle of metamorphic action, independent formations may have arisen, and be still arising, outside of that circle also. Metamorphic and igneous action are but the result of forces acting upon existing rocks—of forces which, acting upon free, simple elements, might as easily form original rocks.

On the other hand, it appears to me that the theory of igneous eruption as applied to granite and greenstone is utterly untenable, and for this broad reason, that the further we go in our investigations the more insight we get into the existence of relations between these rocks and those which immediately surround them; whereas eruption is a thing of haphazard, which can have no relation to the point at which it issues. No theory of eruption will explain why our granite is always surrounded by a band of purple killas; why one so-called rock of eruption (granite) is

* *Primary Geology*, p. 319.

in bulky masses, and another (greenstone) in narrow wedges; and why one so rarely comes in contact with the other. If, indeed, our granite and greenstone were in any sense eruptive, that is to say, if they were pushed in a plastic state into contact with the deposits around them, I submit that it was done under such circumstances, and in conjunction with such unknown forces, as to make the analogy with modern eruption a point not worth mentioning, nay, tending rather to mislead than otherwise.

When we refer the original or metamorphic operations of nature to vast depths beneath earth or sea, where pressure forbids the formation of steam, where water and mud may become red-hot, and where white-heat reverses (as we are told it does) many of the laws that act upon the earth's surface, we deprive ourselves of all excuse for confident speculation or dogmatic assertion. In that unknown sphere there must be room for all the agencies to which every theory has appealed—aqueous, igneous, chemical, electrical, mechanical—sometimes one prevailing over the rest, sometimes all inseparably mixed together.

A CONTRIBUTION TO

THE THEORY OF MINERAL VEINS.

By Robert Hunt, F.R.S.

Two constants appear to have been established in relation to the phenomena of metalliferous deposits; one is the uniformity of main general direction of the productive lodes, and the other is the influence of the proximity of dissimilar rocks. It is very desirable that every possible information upon these points should be collected and recorded, as such a record would serve to establish upon yet more certain data the universality or otherwise of these positions.

Two hypotheses, or perhaps three, appear to prevail as to the origin of metalliferous veins. One, and that is the least generally adopted, is, that they have a purely igneous origin; that their contents indeed have been sublimed from great depths, and condensed against the sides of the vast fissures through which the vapours made their escape from the profound depths at which they were formed. Another view is, that the fissures now forming mineral veins were the vents through which thermal waters, highly charged with mineral matter, were forced to the surface; that from these hot springs there were

deposited, layer after layer, against the colder sides of the cracks the metalliferous and earthy matters which they held in solution. According to Mr. John Arthur Phillips, this condition can be actually observed going on in some parts of California. Highly silicious waters are forced through rents in the rocks, in which they deposit their silica, usually in the gelatinous condition; and in this soft silica are found particles of iron pyrites, and even gold. The other view supposes waters to have penetrated from above, and that in passing through the rock fissures, which were the natural channels of aqueous circulation, these waters deposited, under the influence of what Sir Henry De La Beche called "rock-conditions," and which Mr. Robert Were Fox and M. Becquerel referred to electrical action, their metallic and earthy salts, forming the lodes as we find them. Admitting that my leaning is towards the latter hypothesis, seeing that the repetition of some of Mr. R. W. Fox's experiments fully confirmed the results obtained by him, I do not desire at present to advocate either one or the other of these views. I only desire on the present occasion to support the view that fissures, whether the natural joints of the rocks or rents subsequently formed (it signifies not), were originally formed, and that in those, under one or other of the conditions named, there circulated fluid matter holding the metalliferous or earthy minerals in chemical suspension. Presuming this to be granted, I will mention a few experiments which go to show that, without calling in the aid of electricity, there exists

a power capable of producing all the phenomena observed. I would have it distinctly understood that I believe electrical energy to be a directing power regulating the place of deposit, but that we are gathering evidence of a vast power common to all matter, capable of producing all the phenomena of mineral lodes. Capillary attraction has been long known. Exosmose and endosmose action has been made tolerably familiar to us. The influences of cellular bodies in condensing fluids within them, and the absorbent powers of porous masses, such as spongy platinum, charcoal, and the like, have been repeatedly shown. It is only lately, however, that we have become acquainted with the facts, that a certain thickness of silicious sand will separate salt from its solution in water, and that agricultural soil deprives the water percolating through it of the organic matter dissolved in it. M. Edmond Becquerel has lately shown, that if two plates of glass are so arranged (by touching at one end, and being kept slightly open at the other) so as to show the capillary curve of attraction, and if between these plates we pour a solution of some mineral salt in water, that the surface force will separate the metal from its chemical combination, and attract it to the surface of the glass, on which it will be deposited as a metallic film. Acting upon this, I have made a few experiments, feeling that if we could produce a state of unstable equilibrium in the chemical solution, this metalliferous deposit might take place on surfaces widely separated. By adding to a solution of cyanide

of silver a very small quantity of an hyposulphite, quite insufficient to produce a precipitation, the surface action of the sides of a pint bottle was sufficient to produce this deposition in the form of a coat of sulphite of silver. Aldehyde and grape sugar have a similar power. With porous vessels, this condition can be most readily established, and most beautifully so by the action of charcoal. By putting a piece of freshly-burnt charcoal into a solution of nitrate of silver, we obtain in a little time very beautiful crystals of silver, and this, be it remembered, is entirely due to the influence of the surface force distributed over the molecules of carbon, arranged to form the cells of the carbonized wood.

Experiments are yet required to determine the extent to which this surface force is brought into action. But when we see the manner in which small cracks get filled in with metallic matter, such as copper and silver, and when we meditate on the power with which crystallyanic force is exerted as a mechanical power opening the crack, we can, I think, see that we have opened a door through which we may learn something of the secrets of nature's operations in "the dark unfathomed caves of ocean" and of earth.

TOOTH AND FRAGMENTS OF BONES OF HIPPOPOTAMUS,

FROM THE NEIGHBOURHOOD OF CONSTANTINE IN ALGERIA.

By Charles Fox,

President of the Royal Geological Society of Cornwall.

The lofty isolated rock in horizontal layers on which the city of Constantine is built, at a height of 2,000 feet above the sea, appears to be cretaceous, judging from the inoceramic and other shells in it. It is half encircled by the river Roummel, which has worn or formed a vertical cleft 600 feet deep, or has cut its way in one or two places through the rock, leaving a vast natural arch.

Professor Studeler led me to the other side of the ravine and up the ascent of the Mansourah hill, of which the marl rests in almost vertical beds on the limestone. The marl is traversed by thin upright veins of limestone, in which M. Renan, of Marseilles, found teeth of fishes. Walking for some furlongs along the plateau (which has an almost uniform slope to the S.E.), we reached some quarries in the friable sandstone, which does not seem to have a thickness anywhere of more than 50 feet. We soon found, at a few feet beneath the surface, some of the hippopotamus bones (now presented), and parts of the

carapace of an Emys probably. The large tooth was found in the same quarry: it has suffered much from the disintegration of its substance, except at its clearly-defined summit. An entire head of the animal was found in the same plain, which has not in the least the character of a mountain-basin, as its present conformation seems to have little, if any, reference to the hills distant about five miles. The water "tortoise" found in the sandstone, and fossil paludina, and impressions of reeds (or grasses), which I observed in a water-worn calcareous deposit about 100 yards off, indicate the presence of water formerly, where it could not now lie except in the shallowest pools. The bed of the Roummel river is 800 or 900 feet below the plain.

Pudding-stone rests in horizontal beds of marl, where the river leaps out from its rocky prison, and forms a high hill on the west of the city. Gypsum is worked there; and a salt-spring is probably due to the vicinity of rock-salt. In the interior there are numerous salt lakes, some of them six times as salt as the sea.

The French soldiers wade into one, to obtain fresh water from a spring in its midst. Like the great fountain in the harbour of Spezzia, lofty rocks of salt (noticed by Herodotus), and the salt lagoons, as well as *foraminifera*, in mountain masses, show that the ocean once covered this boundless desert.

The cretaceous system is largely developed in Algeria. It is of a dark colour in the northern, and white in the southern districts towards the Sahara.

MM. Cognan and Nicaisi, geologists of the Imperial School of Mines in Algeria, have described about 600 new species of shells in the green-sand; not green, however, there. The Jurassic beds (including the lias in which reptiles have not yet been found) are very extensive. In Mount Aures they are in parts horizontal, in others vertical, as if tilted up through cretaceous rocks.

M. Nicaisi has found bones of unknown Saurians (as he thinks) in the green-sand of that mountain near the surface. Nummulite beds, turned up on their edges, form the highest crests of the Jebel Jujura range (at some points 6,000 feet above the sea), and encircling much of the Kabyle highlands, in which mica schist abounds.

Miocene beds exist in the fertile Metidjah plain, which lies between the isolated group of the Sahiel hills and the lesser Atlas. Lava has pierced through, or has flowed between the beds, or lifted them up into two anticlinal lines. Columnar basalt, trachyte, and other varieties of lava, appear at different places in the whole region.

There are many deposits of gypsum, generally associated with volcanic action. Beautiful specimens of a variety of it, called onyx, were in the Paris exhibition.

At Cape Matafeo, the east promontory of the bay of Algiers, there is a thin bed of lignite near serpentine. Some specimens of the latter rock at Delhys, also on the coast, but further east, [illegible] coal, which seemed to me to be bituminous. As the

steamer touched there at night, I could not visit the scene of this anomalous combination.

The only trace of Devonian rock yet found is a silicified ferruginous stone (not water-worn), which was picked up a by traveller returning from an unsuccessful attempt to reach Timbuctoo. I could distinguish in it numerous small Spirifera.

I present a specimen of a deposit of 80 or 100 feet in height, bordering the Metidjah plain, to which M. Flower called my attention. He considers it to have been a sea-beach when the Sahiel was an island.

The city of Algiers is built on the steep N.E. slopes of the Sahiel, and rests on alternating beds of mica schist and gneiss, which rise at Nowzeriah to the height of 1,000 feet. On the N.N.E. there is a large mass of limestone, extending from the sea to a considerable height; at the point de Pescade, especially, it seems to have been affected by igneous action. Enormous rocks are quarried from it to extend the breakwater of the harbour. A small cave has lately been discovered in this limestone about 80 feet above the sea. I saw in it traces of human occupation, traces (supposed by the geologists present) like those of fire, and a layer of gravel, like that of the neighbouring beach, which might have been brought to make a dry and smooth floor. There were no *human* bones, but many of different ruminantia, and two small pieces of flint, probably fashioned by man. Neither in the Sahiel nor in any other part of Algeria, nor in the collection of the "Ecole des Mines," could I find true granite, except in fragments of Roman

sculpture; but syenite is in North Africa often called granite. Some fragments only of porphyry have been found in the bed of the river Chelif, near Miliana.

In the western division of the Sahiel, thick beds of argillaceous marl rise to the height of 600 feet, where I found terebratula.

Dr. Boujot kindly conveyed me to Douera, where in the same formation we found *Arcæ*, *Pectens*, *Ostreæ*, *Dentalia*, Corals, &c. It was very hot at the time (5th of March), and Dr. Boujot feared lest I should suffer from fever-miasma, which in a previous visit of two hours only had made him seriously ill, and would not allow me to linger to collect many specimens, or I should not present the Geological Society with so meagre a sample of them. These clay beds, from their wide distribution, are at present great obstacles in the way of agriculturists.

Abutting against the gneiss and mica schist of the Sahiel are horizontal tertiary, probably pliocene, beds, forming a beautiful yellowish freestone, abonnding in fossils, of which I beg to present a few specimens.

I understood from my friend M. Flower, that he found 70 new species. I hope that he will favour the public with a memoir on these interesting formations.

The French geologists have not yet completed their map of Algeria, the result of laborious and extensive observations in that vast region, which presents a very inviting field to our English geologists, who would receive a most courteous and cordial welcome from their very able French fellow-labourers in science.

November, 1868.

ON

THE FOSSIL FISH OF CORNWALL.

By Charles W. Peach, A.L.S.,

Corresponding Member of Royal Geological Society of Cornwall.

In 1841, and at several meetings of your Society up to 1849, papers of mine were read on the above subject. These were afterwards printed in your *Transactions*, and some illustrated with plates. Specimens also were deposited in your museum, and especially those of which figures were given. In the papers will be found the localities where they were got, and all the particulars then known about them. It is to those stated to be *fishes* I now allude. I may mention that the late Professor Forbes and others fully agreed with me in believing that many of these organisms were fish remains. Some years after 1849, Professors Sedgwick and McCoy made a geological tour in Cornwall, and, as well as inspecting the Cornish fossils in your museum and that at Truro, and private collections, collected a number also. Those more especially called fish were carefully and microscopically examined by Professor McCoy and Mr. Carter, and pronounced to be, not *fishes*, but

sponges, belonging to the genus *steganodictyum*, and made into two species

So they were considered up to April last, when Mr. E. Wyatt Edgell published in the May number of the *Geological Magazine* a letter, stating that *these so-called sponges were true fishes*, and belonged to a species of *Pteraspis*. Professor Huxley saw one belonging to Mr. Pengelly from the Cornish rocks, and this he said was also a *Pteraspis* "of larger size than any previously known." As the same verdict has been given by Messrs. E. Ray Lankester, Salter, Woodward, and others, I feel bound to accept their decision as final. My opinion had never changed; and although I thought that *sponges* might have lived with these ancient fishes, I felt that the specimens described by me were remains of *fishes only*. On learning this change, I broke open a box of odds and ends, packed in Cornwall in 1849, and which had remained unopened up to that time, when, to my great delight, the first specimen I turned up was a nice but imperfect dorsal-plate of *Pteraspis*. It is 6½ inches in length, beautifully marked with delicate waved lines, and under these in places tubercles, and below all a reticulated net-work. This net-work-like structure deceived Professor McCoy and others, and made them so stoutly stand out against the Piscine character of these really (at that time) ill-understood remains. This net-work structure, they said, was "not to be found in any recent fish." I have, however, met with it in *Osteolepis*, &c., in the old red sandstone of Caithness, and in carboniferous

fishes from the coal-fields of Edinburgh and Lanarkshire. Now, it is to be hoped that all will be settled, and in the beautiful monograph on Pteraspidian fishes, in course of publication by the Palæontographical Society, they will find their proper place.

I might make many remarks on these organisms, and other things connected with them; but from believing that my respected friend Mr. Pengelly, who has worked so long and successfully amongst Cornish and Devonian rocks, will fully enter into the subject, and thus render it unnecessary for me to do so, I shall rest contented with saying that it is a real pleasure to me to find that, though late, my opinion was not a wild speculation after all.

Old as I am getting, it would be a joy to me indeed to ramble over Cornubia, and endeavour to help to work out the true history of the rocks: their true history is said to be still wanting.

I have enclosed a tracing of my large specimen.

30, Haddington Place,
Edinburgh, 28th October, 1868.

NOTICE OF

AN ACCUMULATION OF CARBURETTED HYDROGEN,

OR "FIRE-DAMP," IN THE DING DONG MINE,

SITUATED IN THE PARISH OF MADRON, NEAR PENZANCE.

By Samuel Higgs, Jun., F.G.S.
Secretary of the Royal Geological Society of Cornwall.

The Ding Dong Mine is perhaps one of the oldest tin mines in the world, as its uninterrupted working can be traced for more than two hundred years, many of the present shareholders having inherited their interest for nearly two centuries.* Perhaps no other Cornish mine can record a similar fact, whilst the peculiar names † given to the different lodes, cross-courses, barrows, &c., too numerous to mention in this paper, might well repay the research of the antiquary, and testify to its extreme antiquity.

The sett is entirely in the granite. The nearest approach to the killas is on the south, at Hea-Moor, distant about two miles; on the east, at Ludgvan, about three and a half miles; on the north, at St. Ives, and on the west, at St. Just, the sea boards, distant respectively six and four miles.

---

* The cost-books in existence record the names of Bolitho for nearly one hundred and fifty years, and of Batten for one hundred years.

† Bussa, Malkin, Clukey, Jacobin, Ishmael.

The gas was detected in the 50-fm. level in the Old Ding Dong part of the mine under the following circumstances: The deeper levels in the Old Ding Dong were abandoned about twenty years ago, when the water rose to the 30 or to the 60 from the surface, the adit level here being 30 fathoms deep; but shortly before the abandonment of the deeper levels, a communication was opened at the 50-fm. level, between Old Ding Dong and Ishmael's Mine, about 170 fathoms apart. Some four years ago, owing to the underlay of a rich bunch of tin in an adjoining working, it was deemed desirable to re-open Old Ding Dong, and resume Ishmael. Everything went on well until the 7th August last (Old Ding Dong being in fork to the 70), when, in order to facilitate the draining of the Ishmael part of the 50-fm. level, which is some feet below the level communicating with Old Ding Dong, it was found necessary to put in a syphon, that the water might be conveyed to the Ding Dong engine.

Two workmen, Ralph Daniel and James Harry, waded in through the slime and water for that purpose. They had not proceeded far when a violent explosion occurred, accompanied by a blue flame, which threw them off their legs, and scalded them severely. A few days after the managing agent, Captain Williams, obtained a second explosion by putting in a candle attached to the end of a long staff. This was even stronger than the first, although no injury of any kind resulted. After a short interval, Captain Thomas Daniel entered, carrying a naked candle, when a terrific explosion ensued, which nearly

cost him his life. After this, no one was allowed access to the level until Davy safety-lamps had been procured.

With the permission of Mr. Wellington, the purser, I on two occasions, accompanied by Captain Williams and the pitman, went into the level with the safety-lamps. The result of our first exploration proved to a certainty that the explosive gas was nothing more nor less than fire-damp, as the flame in our lamps elongated its entire length, and a bluish light flickered around it. We found no difficulty in breathing, but simply a peculiar sensation around our nostrils.

At the farthest point we reached, the back of the level was found to have been worked away, and cleared for about 4 fathoms in length and two in height. Beyond this the level was completely choked. It was evident, however, the backs had been worked, and that they had either been filled with rubbish, or had run together.

From the peculiar freshness of the granite here, as well as for a few fathoms back from it, it was clear that although the mine had been full of water for 10 fathoms above, none had lodged here. I would observe that for more than 20 fathoms before arriving at this opening, the level was nearly filled with slime, and through this we were compelled to creep. Here then a space had been left, and this was filled with the gas—without doubt, carburetted hydrogen. Of this the only apparent source was decayed wood (probably the ancient timber-work of the level), the evolved gases from which naturally lodged in this cavity.

On my second visit we went down with the intention of firing it, but did not succeed. I then entered the end with a naked candle. Still no explosion ensued, and I detected merely the presence of foul air. This level still continues free from the gas, as a communication has been made to Ishmael's shaft, distant from this place about 10 fathoms.

I believe the only other record of an accumulation of fire-damp in a Cornish mine appeared in the *Arminian Magazine* for November, 1791; but unfortunately neither date, locality, nor names are given; neither is the name of the author appended, although it must have caused considerable excitement at the time, as it states that seventeen men were killed by the explosion. Such was its force that it hurled the heavy framework of wood on the top of the shaft some distance, which falling on a cottage entirely destroyed it, killing the poor man who lived in it. For this reference I am indebted to the kindness of Miss E. Carne.

My best thanks are due to Mr. Wellington, the purser, and Capt. Williams, the managing agent, for their kindness in furnishing me with much of the information contained in this paper.

November, 1868.

ON THE OCCURRENCE OF

METALLIC ORES WITH GARNET ROCK.

NOTE ILLUSTRATING A SERIES OF COPPER ORES FROM BELSTONE CONSOLS.

By Warington W. Smith, M.A., F.R.S., F.G.S.

At several localities within the counties of Devon and Cornwall, considerable masses of garnet-bearing rock have been observed among the schistose strata where they approach the plane of contact with the granite; and from their proximity to important lodes, or being themselves productive of metallic substances, they have, in a few cases long ago, formed a subject of investigation. Thus the garnet associated with axinite, epidote, and other silicate minerals in the rocks at Botallack, have from the commencement of this society attracted the observation of its members. The "tin-floors" at the same mine, in which oxide of tin was disseminated in bands of greenstone and garnetiferous schist, were described by Mr. John Hawkins in the 2nd vol. of the *Transactions of the Royal Geological Society of Cornwall.* The massive garnet (allochroite) associated with copper and iron pyrites in the remarkable lode of Wheal Maudlin,

near Lostwithiel, is known to collectors in the eastern part of this county; and, a few years ago, workings to some extent were opened at Criggas, 1½ mile south of St. Columb, where, from a kind of gossan having been formed by the action of the atmosphere on a band of crystalline garnets and axinite, and being thus a highly ferruginous substance, it was raised and exported as iron ore.

But the most extensive and commercially important display of minerals of this class hitherto explored, is that which trends along the northern side of Dartmoor in an E.N.E. direction, from the neighbourhood of Sourton to the village of South Zeal, over a length of nearly seven miles. At several places along this line, and within a distance of from a few hundred feet to about a mile of the visible edge of the granite, there have been noticed in the more or less altered killas, which dips away from the crystalline rock, masses of brown and reddish gossan, which have led to the establishment of mining operations. The works have been opened upon courses continuously traceable for a mile or two miles, and apparently in two nearly parallel bands, which on the west, at Wheal Forest, are a quarter of a mile asunder, but on the east have diverged so much as to leave a mile between the run of Sticklepath and South Tawton on the north, and that of Ramsleigh or Fursdon Manor on the south. Many years ago workings were carried on at Sticklepath and at Wheal Forest, on Langstone Hill, which proved the presence of copper ores along with mundic, but led to no satisfactory result.

More recently Black Down was explored in a continuous line with Wheal Forest; Fursdon Manor mine, now Cosdon Vale, was systematically opened; and within the past three years, Belstone Consols (on the Sticklepath lode) have been the scene of regular mining adventures. The importance of these deposits is best shown by the fact that the last two mines have sold copper ores to the amount of several thousand pounds in value, with some of the parcels ranging from 12 to 16 per cent.

The general occurrence of the minerals at these various points is very analogous, and to avoid prolixity, I will confine my description to the last-mentioned mine, which is now opened to fifty fathoms in depth, and many scores of fathoms in length, and which exhibits some of the peculiarities of this series on the largest scale, although removed by greater distance (above one mile) from the edge of the granite. The surface at the Belstone Consols is slightly undulated cultivated land, and here, as at Ramsleigh, a road-side cutting appears first to have brought the ferruginous bands to notice; but the long cross-cuts which have been driven in the former mine, and the numerous costeaning pits opened to prove the course of the metalliferous lines, reveal the structure of the mining ground over a large area.

In the thirty-fathom level the relations of the lodes are most fully exposed. A vertical shaft ("A") is sunk between two veins, termed No. 1 and No. 2 lode, which are seventeen fathoms asunder, and course

true E. and W. They consist of bands of garnet rock mostly crystalline, and containing disseminated copper pyrites, iron pyrites, and mispickel, which sometimes coalesce into a pretty solid rib of from one to three inches thick, now and then associated with quartz. The bands dip very regularly to the north, with an underlay of 2 ft. 6 in. to 2 ft. 10 in. to the fathom; and the ground between them consists of an alternation of garnet rock and dark silicious slates in perfectly conformable strata. Towards the north, near No. 1, these beds (especially as seen in the fifty-fathom level) assume more of the character of ordinary killas. Southward from No. 2 the cross-cut passes through thirty-seven fathoms of similar alternation of garnet rock of greenish yellow and pale brown tints, with sharp silicious schists, and then reaches the north wall of the "main lode" (No. 3), which attains a width, measured horizontally, of no less than sixteen fathoms. To me this appears nothing else than a powerful bedded mass of garnet rock, with a few planes of stratification more or less distinctly visible, and where some of the courses are highly crystalline, with the rhombic-dodecahedrous plainly recognisable, whilst other portions consist of massive garnet or allochroite, or are intermingled with schistose bands of matted pale-green actinolite. This thick band is on the whole softer than what has been regarded as the country, and is specked throughout, but very irregularly, with pyrites, mispickel, and black and grey copper ores, whilst occasionally these metallic sulphides and oxides are accumulated in

strings running sometimes with, but often quite against, the direction of the stratification.

Here and there a little green carbonate of copper appears in some of the reddish and pale-grey beds. The resemblance to a true lode formation is also heightened by occasional ruggy portions, and by heaves which dislocate the orey parts. On the south the cross-cut has been pushed a short distance into strata of a very similar character to and conformable with those on the north.

The entire lode is heaved by a cross-course, on which the above-mentioned cross-cut has been driven to a distance of 9 fathoms south in going west; and a succession of considerable dislocations in the same direction occurs still further west. Below the 30, and in the back of that level west of the heave, considerable quantities of the black ore are being raised from stopes, mostly in portions of the lode where the chief mass is of a soft somewhat gossany character.

Here, then, we have the remarkable feature of a band of 96 feet thick of garnet rock succeeded on the north by above 300 feet thick of alternations of that rock with hard schists, and the presence in them of such large quantities of copper ore suggests several questions of no little scientific as well as commercial interest. The whole series forms distinctly a group of conformable strata overlying the granite. But the highly crystalline character of the garnet portions, the bright faces and the sharp edges of the crystals themselves, preclude the idea of their

having been deposited as such by the usual action to which we ascribe sedimentary formations.

There are certain mining districts abroad where garnetiferous rock associated with metallic ores, as in Scandinavia, in Mexico, and in the Bannat in Hungary, is presumed with tolerable certainty to be the result of metamorphic action. And in the region before us it would appear that a similar explanation is the most probable, and that these bands, which as simple sediment contained the materials needful for the formation of garnet, actinolite, and axinite must have become definite and crystalline under the influence of the neighbouring granite. This position would appear to be confirmed by the circumstances that it is only near the granite that such appearances are seen, and that the same effect has here been produced on the lower carboniferous strata which in parts of Cornwall are observed in the Devonian.

But how to account for the metallic ores? They occur differently from what we find them to do in lodes not limited within nearly contiguous walls, as if resulting from the filling of a fissure, and it becomes for this district a highly important question, now in process of solution by Messrs. Martien, York, and Co., to determine whether the ores may be expected in such a repository to occur in sufficient quantity, and thickly enough grouped, to be remunerative to adventurers.

Has there been, let us enquire, an opening and a filling of the lode-fissures precisely coincident with the course of these unusual beds? It appears to

me, from the regularity of the strata as well as a prevalent absence of true lode-structure, to be very improbable.* Or, may we conclude that the ores were deposited along with the original sediment of the strata? Such a hypothesis, looking at the history of the occurrence of the copper ores in our Western counties, and the manner in which they here accompany bands only of a particular mineral character, would seem to be just as improbable as the former.

It appears as though we could not escape from the admission that the ores must at one time have had the opportunity afforded them to select those channels of ground that were in mining parlance "congenial" to them, and that the thicker bands of garnet and actinolite rock were in this respect highly favourable to their deposition. Where so bulky a stratified mass of rock as the so-called main lode has been exposed to the action of the chemical forces which have induced its crystallization, and to the physical violence which has tilted it to a high angle and broken it up with numerous joints and fissures, it is fair to infer that an easy access was afforded to waters laden with metallic combinations which would deposit them as definite minerals. But why, if the whole series of strata were at one time saturated with mineral waters, should the valuable contents be limited to certain bands of rock? And what probability is there, that

* The constancy in the direction of these metalliferous bands is certainly a feature establishing a sort of relationship with the lodes; and it is significant that the prolongation westward of these of Wheal Forest will nearly strike upon the cupriferous deposit at Bridestowe, which was described by Capt. Simmons to the Miners' Association.

in these latter certain portions may be richer than those hitherto explored? What that in depth the chances of success may be as good or better than at the shallow levels? These questions follow one upon another as we think over the appearances thus brought to view, and we may assert that no definitive reply can at present be given as derived from experience at other copper mines. It is obvious enough that a little more knowledge of these peculiar phenomena would greatly benefit a whole district; but such knowledge has to be dearly bought in the slow opening of shafts and levels with hard ground and quick water, and the object of this brief sketch is to point out that a record of the results of so interesting a series of trials cannot but be of high value to the geologist as well as to the miner.

ON SOME FOSSILS FROM MOUNT LEBANON.

By Alfred Lloyd Fox.

The fossils from mount Lebanon which I have sent to the Royal Geological Society of Cornwall were for the most part collected by my companion and myself during our rambles, in the winter of 1867-68, through that portion of the range lying between Jebel el Sunnîn to the north and the Litâny, where it cuts its rapid channel through the deep chasm between the height capped by the ruins of the strong old castle of the crusaders, Kulat el Shukîf, and the little village of Deirmîmas, where we slept, on the opposite precipice.

The fossils observed by us chiefly consisted of mollusca; viz., casts of Isocardia, and allied bivalves, and of Buccinidæ and Conidæ, and shells of Hippurites and of Ostreæ, which we found abundant over a large area, but clustering in larger numbers in certain favourite localities.

Near half a mile to the north of the village of Shemlan, about 2000 feet above the sea level, about fourteen miles from Beyrout, Radiolites (hippurites) cornu-pastoris, a characteristic fossil of Coquand's angoumian stage of the middle cretaceous series, was very common, also Ostreæ. Immediately to the south-east of this village is a hard and compact nummulitic

limestone. We were informed that Turrilites and Pholadæ were to be found lower down on the mountain, a stage corresponding apparently to the Rhotonagian of Coquand, marked by Turrilites costatus, of which I have sent a specimen. Above Shemlan and Sook el Ghurb we found compressed specimens of Buccinidæ very common. Above B'Hamdun, near the watershed of the Range, we were struck with the profusion of fine sharp casts of isocardia, whilst in the valley of Muchtara (the head-quarters of the Druses), and under Kulat el Niha, and towards Jezeen, we found casts of large Conidæ, which latter we were prevented from taking with us in consequence of their weight and the long journey before us.

One fossil, a rolled specimen, found some 3000 feet above the sea level near B'Hamdun, bearing a remarkable resemblance to a large carnivorous tooth, or to a noble molar of an old giant of Bashan, caused considerable dispute, until Professors Owen and Tennant gave it a place among the characteristic fossils of the hippurite limestone, and considered it to be a valve of a large hippurite.

I wish to make particular mention of the accompanying good specimens of fossil fishes, for which I am indebted to the kindness and energy of a French gentleman, L. Mazin, of the Jesuit College at Ghazir, to the north of Beyrout; also of those of a good cast of ammonite, buccinum, coral or shell-spawn, &c., all found by him, I believe, within some miles of Ghazir.

For a few of the specimens I have to thank an

American gentleman, William Bird, of the American Seminary at Abeih, near Beyrout, whose private collection of fossils at Abeih is well worthy the inspection of any geologist visiting the Lebanon Some of the small shells given by him appear to be casts of Paludina, Limnea, &c., and therefore are of lacustrine and fluviatile origin, showing that a complete change must have taken place at this period of the chalk formation. Did not these fresh-water shells exist in some lake in which were likewise deposited the vegetable matter that afterwards formed the lignite beds, of which I have sent a small specimen? Such is Coquand's explanation of the appearance of similar shells and lignite beds in Provence. There these fresh-water shells are traced to the base of the Eocene. Do not those in the Lebanon belong either to the Upper Chalk or to passage-beds between that and the Eocene?

The great difference that exists between the cretaceous deposits of England and of the valley of the Seine on the one hand, and those of Provence and Algeria on the other, are well known. Do not the Lebanon beds, distinguished by hippurite limestone and lacustrine deposits, bear great affinity to the latter, and contain many strata of the cretaceous system which are altogether absent in England? We also observed here and there courses of rich iron ore, and a fine elvan-course to the east of the Wady et Teim, south of Rasheiya el Wady, in the anti-Lebanon.

In many places, as we rode along, we found fossils lying by our road-side in great profusion.

REMARKS ON (WITH A LIST)

SOME OF THE ORGANIC REMAINS OF CORNWALL,

IN THE MUSEUM OF THE ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

By C. W. Peach, A.L.S.,
Corresponding Member of the Society.

I had great pleasure in the spring of the present year in accepting the kind invitation of the authorities of your Institution to assist in arranging some of the fossils in the really elegant and spacious museum lately erected. It has been very gratifying (with one or two exceptions) to find the *whole* of the fossils formerly belonging to me, not only there, but, considering the long time—twenty years, or nearly—they had been in the old museum, with their removal to the present one, *in good condition and preservation, even to their labels.* As well as the above, collections made by Messrs. Treffry, W. M. Tweedy, W. Jory Henwood, Pengelly, Giles, Pattison, &c., were also turned up. From all, the dust and dimness were removed by the industrious ladies, who, with unceasing perseverance, prepared the specimens for arrangement on your shelves. Unfortunately, at present little or nothing can be done towards naming the collection correctly: so many changes have taken place, and are still going

on, in the nomenclature of fossils, we are compelled to wait. Even the geology of the county is not yet settled. We hope this will soon be done, and that the officers of the Geological Survey will re-examine the county, and set the vexed question of the age, &c., at rest. With this, with the excellent monographs of the Palæontographical Society, and the use of your specimens by the writers of these monographs, new light will be thrown on all, and your large collection will become, not only a standard of reference to your native rising geologists, but to all interested in the Devonian or old red sandstone of the world.

There is still much to be done in the county in the way of research in the field; all has not been discovered. It would not surprise me to hear of fossils being found much nearer to Penzance than Porthalla.

With this I forward a list of some of the fossils in the two wall glass-cases; these, with two or three exceptions, were selected out of those collected by me before I left Cornwall, in 1849. The remainder, mostly duplicates (many of these might be exhibited if room could be found), are placed in drawers. A large number of the "*Steganodictyum*" of McCoy were selected, and are now in the hands of Mr. E. Ray Lankester for description in his *Monograph of the Fishes of the Old Red Sandstone.* Happily these, said to be *sponges*, are fishes again after all.

I regret that the list is so imperfect, and must ask you not to rely too confidently on it as regards

species, for the reason above given. Many were named twenty-five years ago, all gleaned from various sources scattered here and there, and now probably superseded. However, they may serve as an incentive to some one to set all right. I need not make any remark on the Silurian part; this has already been so well done by Sir R. I. Murchison.

As regards the "Devonian," I have not attempted to give the divisions; at present these for Cornwall have not been defined.

LIST OF THE ORGANISMS.

Plantæ. The rarity of these is marked. The two specimens in your museum are the only ones I ever knew from Cornish rocks. The one I got at Polruan is small, and marked by me when got. I have since seen thousands in Scottish rocks, and adhere to my first opinion. The other is a fine specimen from Mr. Giles's collection, from near Liskeard. It is much like a not uncommon plant of the old red sandstone of Scotland, where it occurs at times two or three feet in length, and of the same breadth all the length; it has also the same kind of raised centre, and as well *oblique* markings, probably from shrinkage.

Amorphozoa, now *Steganodictyum*, is taken from this class. We have only one. It is a very interesting one, and has not been found in any other place than South Devon. *Sphæronites tesselatus* is a curious and interesting sponge, and is a valuable addition to the Cornish list.

Cœlenteratæ. These are found in many localities,

generally ill-preserved. It is pleasant to be able to notice one species, a *Favosites*, at *Porthalla*.

A large undescribed *Favosites* occurs at Polruan and Fowey; it is far from uncommon. I saw one two feet six inches in length. Portions of specimens (now in your museum) are figured in your report for 1848, page 62, plate iv. figs. 7-9.

Pleurodictyum problematicum is abundant, and a "true Devonian fossil."

Echinodermata. Pretty generally distributed throughout the county, more so than any other fossil. On the whole they are in detached pieces. Those from Porthalla are in the same specimen of limestone as the *Favosites*. (No. 733 of Dr. Boase's collection.)

Annelida. The only one at present known occurs in sandstone, with prints of ripple-marks and raindrops, in Highgate Quarry, St. Veep. Was first noticed as Cornish in 1850. (See Report, page 125.)

Crustacea. Far from rare, especially at Rose Vale Quarry, near Liskeard. Many of them are rather large. (See the one figured in your Report for 1848, plate iii. figs. 3-5.) Unfortunately few are in a recognisable state of preservation.

Polyzoa. Though not numerous, interesting examples, mostly casts, occur at Polruan, Fowey, and Looe.

Brachiopoda. The most interesting is *Lingula*, it being an addition to the Cornish list. Although marked by me with (?) twenty-five years ago, I felt it right to submit it to Mr. Davidson, who kindly complied with my request. A copy of his reply ac-

companied this. These must be considered *standard specimens.* Lingulæ have been found in the Devonian of North Devon, and in the carboniferous rocks there.

Copy of Mr. Davidson's letter to Mr. Ethridge on the Lingulæ from Cornwall.

My dear Mr. Ethridge,—It was only this day that I could spare a moment to examine Mr. Peach's *Lingulæ.* The rock which contains them seems exactly similar to those upper shales which occur at Stoly or Plaistow Mile Quarry, parish of Shirwell, in North Devon, and the species seems identical with that named *Lingula mola,* by Salter, and which I have considered might be a variety of *Lingula squamiformis.* See my *Devonian Monograph,* p. 105, pl. xx. figs. 11, 12.

I can make nothing positive of the Pridmouth species, as it is so entirely out of shape; but it might, perhaps, be either a *Lingula* or *Discina,* similar to one which at Stoly contains the Lingulæ.

(Signed) T. DAVIDSON.

Lamellibranchiata. A few specimens of each division, mostly on the east side of the county.

Gasteropoda. Rare and poor in species. *Loxonema* is found in the same rocks as the fish remains, and with *Bellerophon bilobatus* (see next class) are interesting, showing *fishes and marine shells together* in the same rock.

Nucleobranchiata. At present only two; one above interesting.

Pteropoda. Hitherto confined to North Devon. First mentioned in vol. vi. of your proceedings for 1844, page 184. It occurs in three localities in Cornwall.

Cephalopoda. Many interesting specimens in several

localities. The fragment from Porthalla for the first time.

Pisces. Your collection is rich in specimens. I have reason to believe that in genera and species more will turn up than expected. When decided they will have a very important bearing on the geology of the Devonian and old red sandstone.

At present, for reasons given, we do not appear to be rich in species. However, we have fifteen out of the eighteen classes noticed by Mr. Ethridge in his paper on "The *entire* Flora and Fauna of the Old Red Sandstone and Devonian Rocks of Great Britain," in the *Quarterly Journal of the Geological Society of London*, December, 1867, page 615, table ii., represented in Cornish rocks. The three wanting are—Rhizopoda, Insecta, and Reptilia. The two last can hardly be expected to turn up.

30, Haddington Place, Edinburgh, 26th October, 1869.

ON THE

DISCOVERY OF ORGANIC REMAINS IN THE ROCKS OF NELLY'S COVE, NEAR PORTHALLA;

AND OF

SOME CURIOUS ORGANIC-LIKE MASSES IN A QUARRY NEAR HAYLE.

By C. W. Peach, A.L.S.,
Corresponding Member of the Society.

On the 3rd of May last, when looking over in your museum the Boase collection of the rock specimens of Cornwall, one of limestone (No. 733), from near Porthalla, arrested my attention. A slight examination satisfied me that it was fossiliferous. At my request the authorities kindly got it partly polished, and then *crinoids* and *corals* were clearly shown. The specimen and fossils are much like masses got by me west of the Van, in St. Austell Bay, now in your museum. From being long of opinion that fossils might be found between the Narehead and Mount's Bay, this discovery was so interesting that I resolved to go to Porthalla, and try to refind the rock Dr. Boase took the specimen from. I was to have had company. Unfortunately, the weather was so wet and stormy, I had to go alone. In addition to the pelting rain—with the exception of one day out of the five—the tides did not serve for beach-ranging. Despite

these drawbacks, I tried all possible, both under and on the top of the cliffs, from Porthalla to beyond the Nare point on one side, and on the other some distance beyond the serpentine rocks. I also made a slight examination at "Proustock" (Porthoustock). I was not fortunate enough to find the limestone of Dr. Boase. Had I been in possession of the information since received, in all probability better luck would have befallen me, and I should not have stuck so close to the sea-coast. The following extract from a letter from Dr. Boase of the 22nd ult. may be useful should any of the working bees of your society go to Porthalla—"I heard from my friend Henwood of your interesting discovery of organic remains in a specimen of limestone near Porthalla, and have since seen in the papers reports of your researches on this subject. I have read over the part of my communication to the Geological Society of Cornwall, and have tried to recall the matter to memory; but a period of about forty years makes the recollection very unreliable; but as far as I can penetrate the gloom, I think the specimen *was broken from a point of rock cropping out of waste ground on the top of the hill on the road from Porthalla to the Lizard.*"

I saw this rock across the deep valley on my left hand as I went on the footpath from St. Keverne to Porthalla, but did not go to it, being *assured* by several that it was the same kind of rock (serpentine) as that which shows in the cliff on the right of Porthalla Cove. For once—I suppose owing to the wet weather and weariness from cliff ranging—I did not examine

for myself, a most unusual thing in these matters with me. Thus I lost the prize; however, I hope some one will soon get it. My journey was not altogether fruitless; for in Nelly's Cove, between tide marks, in the rocks which show above the sand before reaching the high ridge on which the raised beach rests (as represented by Mr. De la Beche at page 431, fig. 80, of his Geological Report), I got blackened masses in a dark grey rock; one piece is evidently a portion of an *Orthoceras.*

Similar blackened ones are in the collection in your museum from Fowey, Polruan, &c., and it would be well to compare them. I regret that the specimen is so obscure. With me there is no doubt. I have shown it to one well up in fossil lore, and am fully borne out in my opinion. The other specimens from that locality I say nothing farther about than that many such are found with the organisms in the rocks of Polruan, &c., and they are no doubt portions of mutilated organisms. The cliffs, quartz cairns, rocks, &c., remind me much of those of Goran Haven, the Deadman, and Veryan, &c. I think the quartz at the Nare is a continuation of that at Goran Haven, Caerhayes, and Veryan, and that if very carefully examined will be found to be fossiliferous.

QUARRY AT HAYLE.

At Miss E. Carne's request, I accompanied that lady and Miss Batten to Hayle for the purpose of examining the rocks there, and in the quarry opposite the mineral floors we got several nice pieces of

curiously striated rock *in situ* (evidently not slickensides), much like impressions of calamites, so much so that had they turned up in a coal-field, I should have considered them truly so. One specimen I left in your museum; unfortunately, I did not keep one for myself. I refer to these specimens from having read in the September number of the *Geological Magazine*, page 393, the account of "Fossils in Eophyton Sandstone in Sweden." The paper is illustrated with three plates: in plate xi. fig. 3 is one so like the Hayle specimens, that it would be well to search farther, and if shells (lingulæ) also turn up, then probably we shall have the equivalent of the Eophyton sandstone in Cornwall. I saw at the Geological Rooms, when in London in June last, some of the Swedish specimens of Eophyton sandstone with the fossils. *Not a vestige of organic matter was to be seen.* After seeing these and the plates, and having read the paper above alluded to, rest assured *if the Swedish specimens are truly organisms, so are the Hayle ones;* and I hope that you will soon re-discover the Porthalla limestone, and work out the Eophyton (?) riddle too. I forbear any remark on the geology and rocks, dealing only with fossils; for I fear I have intruded too long already.

5th November, 1869.

SOME OBSERVATIONS ON THE MAGNESITE OF SILESIA.

By Lovell Squire, Jun., B.A.

In the course of a tour through North Germany in the spring of 1868, the writer spent a week or two in the county of Glatz, in the south of Silesia, and availed himself of the opportunity to examine the magnesian formations in the vicinity of Frankenstein. As this district is out of the usual track of English travellers, it is thought that a brief account of the remarkable deposits of magnesite which its contains may not be wholly uninteresting to the Cornwall Geological Society, our own county being so rich in rocks of allied origin.

It is right to state that the compiler of the present paper is under obligations to an admirable essay by Mr. Wilhelm Richter, of Breslau, entitled, *De eo quod ad Frankenstein invenitur Magnesito*, which was kindly lent him by the Protestant pastor of Frankenstein.

Native carbonate of magnesium (or magnesite) occurs in both the crystalline and amorphous state in various parts of the world; but, so far as we know, it has not been noticed in the British Islands. The amorphous variety, of which we have now to speak, is

stated by Richter to exist in the following localities: Frankenstein, in Silesia; Kranbat, in Styria; Strubschitz, in Moravia; Greece; Madras, and Salem, in India; and on the river Pitsch, in California. Nicol mentions also Valecas, in Spain; and Dana quotes two or three localities where it is found in the United States. The Jermyn Street Museum, in London, contains a specimen from Turkey. A few days ago the writer had a specimen of serpentine from the Shetland Islands put into his hands by Mr. A. Lloyd Fox, which is partially coated with a white substance, having every appearance of being magnesite; but there is not enough of it to afford a satisfactory analysis. A distinct evolution of gas was observed on treating it with an acid.

Magnesite is rarely if ever found perfectly free from an admixture of other substances; but the Silesian deposits are for the most part sufficiently pure for practical purposes.

A recent analysis of a sample from the Frankenstein district is as follows; say in 100 parts by weight—

Carbonate of Magnesium . . .	93·00
Silica	5·60
Alumina	0·85
Carbonate of Calcium . . .	0·40
	99·85

Rammelsberg says the silica varies from 5 to 8 per cent.; but in some cases where the magnesite is very gritty and impure, it would doubtless contain much more than this. The carbonate of lime does not seem to average more than ½ per cent.

In order to gain some idea of the locality, which is the only available source of magnesite in the North of Europe, let us imagine ourselves standing among the ruins of the old castle of Frankenstein, on the southern edge of the vast plain that stretches across Prussia from the Baltic to Bohemia. Level though the country appears, there is a gradual elevation as it recedes from the coast, and the meadows around us are some 500 feet above the sea. The eastern flank of the Riesen-gebirge (which is in this part a mere assemblage of green hills of no great height tumbled pell-mell together) shuts in the view to the south-west at a distance of about seven English miles; and in the intervening space to the southward of Frankenstein, the village of Baumgarten lies concealed among a group of hills, isolated outliers of the mountain-country beyond. It is along the sides of these hills around Baumgarten that the magnesite quarries are chiefly to be found; and we accordingly turn our steps in that direction. We make our way across the Groch Berg, noticing a few old worked-out quarries on the hither side as we go along; and on arriving at the eastern declivity, signs of operations now in progress become visible. It is a large grass field, and here and there we observe a heap of white stones. On approaching nearer we perceive the cavities from which these have been raised—pits sometimes saucer-shaped, and sometimes (but less frequently) sunk like a well or shaft to a depth of perhaps ten or fifteen feet, with adits in some instances driven into them from lower down the hill.

The magnesite is hewn out in blocks very much resembling in appearance the Cornish kaolin, known as china stone; and an intelligent young peasant whom we meet with tells us that the farmers eke out their earnings by sending their men and horses, when there is nothing better for them to do, to raise the "white stone," as they call it, from the fields, and deliver it for a small price to the merchants' yards at Baumgarten and Frankenstein. We enquire how they know where to dig for it, and learn that this primitive kind of mining is carried on (like some other more expensive operations nearer home) very much at haphazard. They dig a pit anywhere at random, and if they do not find the mineral they are in quest of, they move on and try somewhere else. They find it generally in what they call "nests," the subjacent rock (which appears to be invariably serpentine) exhibiting after the removal of the magnesite a subconcave, or, as we have termed it, a "saucer" shape, as if a hollow had been formed in the silicious rock, and then filled up with a deposit of the carbonate. We ask if they do not sometimes try sinking a little deeper; but this seems to be regarded as too Quixotic an enterprise to be thought of; and from the character of the surface-deposits it is probable that they are right in not expecting to be rewarded for the cost of mining. On handling the stone, and trying it with a penknife, we find that it varies considerably in texture and hardness; and upon enquiry we learn, as we expected, that there is a corresponding difference in the value. Much of it contains a large quantity of

hard silicious matter, and is comparatively worthless; whereas the better qualities, with a minimum of impurity, are similar in consistency to chalk.

We pass on to the works more immediately contiguous to the village, and here find the quarrying carried on more systematically and continuously, but with no essential difference from what we have already seen. The men engaged in these works (which belong to the magnesite merchants) are not disposed to be communicative, and appear jealous of a stranger's approach.

On both sides of the village of Baumgarten, along the flanks of the hills, we see at intervals the piles or stacks of white stone, reminding us forcibly of the china clay district around St. Austell. At Baumgarten we pay a visit to the establishment of Mr. Stilbig, who is one of the two or three local men that employ steam-power for pulverising the magnesite, and we obtain permission to enter the mill and see the process. The blocks of stone are first crushed by stamps like those used for crushing ores in Cornwall, and after being thus reduced to small fragments, are ground between millstones to the fineness of flour. We cannot discover that any process of washing away or otherwise separating the silicious particles is adopted; and it is probable that the manufacturers of the powdered magnesite (or dampfrnehl, as it is called) simply rely on a careful selection of the stone to be crushed, the produce of the best quarries being tolerably pure in its native state.

There are at Frankenstein, Baumgarten, and Fran-

kenburg about twenty owners of magnesite works, most of them coming under the class of peasant proprietors, and disposing of the stone they raise to the three or four exporting merchants.

Germany and France appear to be the principal consumers, magnesite being a very convenient substance from which to obtain the carbonic acid gas employed in the manufacture of champagne and aerated waters. Every practical chemist knows the objections to the use of chalk or any carbonate of lime for the production of carbonic acid. If we treat chálk with a solution of hydro-chloric acid, the volatility of the re-agent causes some of it to come off with the carbonic anhydride, and necessitates a tedious subsequent process of purification; and moreover, the disengagement of the gas is apt to be inconveniently rapid; while, if sulphuric acid be used, the sulphate of lime produced being nearly insoluble, forms a kind of plaster, which hinders the complete decomposition of the chalk. The substitution of magnesite for carbonate of lime obviates all these difficulties. By treating the former with sulphuric acid, a slow and regular evolution of carbonic acid gas is secured, and the sulphate of magnesia being readily soluble, the whole of the magnesite is decomposed and utilized, while the residue has a commercial value as Epsom salts. In processes where large quantities of carbonic acid gas are required, it can be obtained from magnesite by simple calcination, as in lime burning, the gas being given off at a much lower temperature than from limestone. It is said

that the facility of its expulsion by heat from a magnesian carbonate first led to the study of the properties of carbonic anhydride. Another use, for which magnesite is especially adapted, is the cleansing of boilers supplied with sulphurous water, the solubility of the sulphate of magnesia produced preventing incrustations such as result from the employment of lime.

Numerous other applications of a similar character will readily suggest themselves, besides the obvious value of the magnesia as a drug, and for the manufacture of magnesium; and it is only strange that so valuable a mineral is not better known in this country. A few importations have been made into England for making Epsom salts, and probably for magnesium works, but not, it is believed, to any great extent.

So much then for the economic value of magnesite. Let us turn to its geological associations, and see if they will throw any light upon its origin. For this purpose it is needful to cast a glance at the rocks to which it is found in proximity, and especially the old quarries (already cursorily referred to) from whence it has been removed. The hills about Baumgarten consist in great part of greenstone, diallage, and similar rocks, intermingled with quartz and masses of serpentine, and, as has been already mentioned, it is in juxta-position with the latter that the deposits of magnesite occur. It may be worth a passing remark, that magnificent specimens of the variety of chalcedony called chrysoprase are found in these hills. The Frankenstein serpentine is peculiar in

appearance, being of a dark colour, and the surface very much cracked and apparently weathered. In the smaller hollows or "nests" from which magnesite has been excavated there is nothing very remarkable in the look of the exposed rock; but when we meet with a larger surface where we can trace the "joints," as in the nearly perpendicular sides of some of the old quarries, we are forcibly struck with the resemblance to a wall of masonry, the interstices of the joints being filled with magnesite, just as if the serpentine had been built up in blocks and cemented with mortar. In some places a certain asbestos-like fibrosity of texture may be observed pervading both serpentine and magnesite at their point of junction. The deposits of magnesite seem always to occur either close to the surface of the ground or where there is a direct communication with the surface by fissures of the rocks, and we are thus led to suppose that it is not of Plutonic origin. Its invariable juxtaposition to serpentine further shows that it is not a sedimentary aqueous deposit, as in that case we should expect to find it superposed on all the rocks of the district, and not confined to one kind only. There appear to be no indications of an organic origin, and we are driven to the conclusion that it has been produced by chemical action since the adjacent serpentine has been in its present position.

Assuming then, as we seem justified in doing, that the magnesite owes its origin to some metamorphic process which has acted upon the serpentine *in situ*, it remains to consider what that agency can have

been. The whole question of the metamorphoses of mineral substances is surrounded with so much obscurity, that it is with great diffidence the writer ventures to offer a few remarks on the problem before us. Were there any proofs that hot springs charged with carbonic acid existed, or had existed, in the Frankenstein traps, it would be easy to assign to such an agency the alteration of the magnesian silicate into a carbonate, the solvent power of acidulated water at a high temperature being well known; but it does not appear that anything of the kind has been even suggested in the present instance, nor does the position of the deposits seem to tally with such a supposition. The weathered appearance which the serpentine exhibits, points, on the other hand, with sufficient clearness to atmospheric action; and the circumstances under which the magnesite is found, all accord with the theory that the principal metamorphic agent has been rain-water. It seems difficult to understand how such a cause should be adequate to the effects produced; but if we consider the analogous case of the decomposition of granite, we may perhaps gain some light on the subject. By the action of moisture derived from the atmosphere, and containing carbonic acid, the silicates of potash, soda, &c., in felspar rocks are (according to Mr. Jukes) converted first into carbonates and then into bi-carbonates, which are dissolved and washed away, leaving behind the nearly pure silicate of alumina, denominated kaolin, or china clay.

Now it is known that if we add a small quantity of

the solution of an alkaline silicate to a solution of hydrochloric acid, the silica, instead of being precipitated, is retained in solution, and may be separated by dialysis from the alkaline chloride and the excess of acid. There is thus no difficulty in supposing that silicic acid may be removed in a soluble form by acidulated water from rocks undergoing the process of decomposition, provided that the silicates are sufficiently amenable to the solvent fluid. To apply this to the case of the felspar of disintegrated granite, we may assume that the silicates of potash and soda are first dissolved by the carbonated rain-water, and that the silicic acid, set free by their conversion into carbonates, is then carried off with these in solution. The question remains, Can a similar theory be regarded as admissible in the transmutation of serpentine into magnesite? In both cases we have strong reason to attribute the effect produced to atmospheric action, and in both cases the deposit consists of a friable chalk-like substance, very free from iron or other colouring matters. But there is this important difference: the silicate of alumina derived from the felspar is the insoluble residue which remains unaffected by the chemical action that has taken place, while the carbonate of magnesia is a new substance produced by chemical action. In the first instance, the double silicate of alumina and an alkali has simply lost the silicate of the alkali. In the second case, the silicate of magnesia has been deprived of its silica and had carbonic acid substituted. Nevertheless it is possible that there may be a closer

analogy than one would suspect between the processes that have taken place in the two cases. Bischof tells us that even those silicious rocks in which the silica exists in its less soluble modifications are unable to resist the long-continued action of acids; and with so high an authority to support us, we may venture to maintain at all events the *possibility* that the magnesian silicate of the serpentine becomes gradually dissolved by rain-water charged with carbonic acid, in the same way as the more tractable alkaline silicates of the felspar, and that it is in like manner converted into a carbonate. But the carbonate of magnesia is not like the carbonates of potash and soda, a readily soluble substance, and instead of being carried off in solution it would be precipitated as soon as formed, while the silica (supposing it to be kept up by an excess of acid) might, as in the former case, be washed away. We should thus have the magnesite deposited nearly pure, as we actually find it; and without pretending that there is any proof that this explanation is the true one, it may perhaps be deemed sufficiently consistent with facts to be accepted in default of a better. In Mr. Richter's pamphlet he directs attention to the fragments of serpentine frequently found among the *débris* of the old quarries coated on both sides with magnesite, and seems inclined to infer that one at least of the surfaces has undergone a metamorphic action since being detached by the hand of man from the adjacent rock. If this be so, it would indicate that the process of transformation is proceeding

with great rapidity; but it may be safer to suppose that such coated fragments have been broken off from places where the serpentine rock has had a number of small fissures very near together filled with magnesite, in which case the line of fracture would naturally follow the course of the softer mineral, and might easily give rise to the appearance described. When nature acts by feeble atmospheric agencies upon such stubborn materials, we may well imagine that time has been (as in so many other geological changes) the principal factor in working out the result.

November, 1869.

THE GEOLOGY OF LUNDY ISLAND.

By Nicholas Whitley,
Honorary Member of the Society.

The island of Lundy is three miles from north to south, and rather more than half a mile in width, and throughout its entire length is composed of a mass of granite, which forms bold cliffs on its western side, and steep slopes with rocky cairns on the east. Its surface forms an undulating table-land about 400 feet high on the south, and falling in height as it narrows in width towards the north; the surface also inclines towards the west, so that the prevailing westerly winds have a clear sweep over the island.

At its south-eastern extremity there is a small patch of slate about half a mile in length, and terminating at Rat Island, forming about one-tenth of the whole island.

The map shows the position of the granite and the slate, the direction of the joints of the granite, and the strike of the beds of slate, which are accurately laid down by the compass. My object in making the survey was to compare this outstanding patch of granite with the granite bosses of Cornwall, with especial reference to the direction of the joints

and the contact of the granite with the adjoining slate.

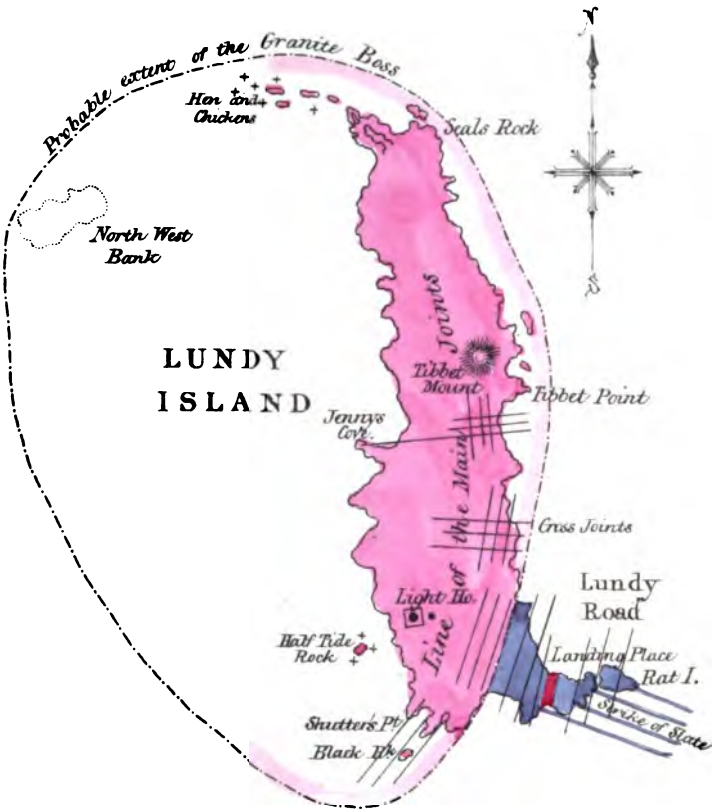
By referring to the map, it will be seen that the main joints have generally a north and south direction, and that the lines are parallel to the line of junction of the granite with the slate, and form a curved line along the eastern side of the island, and thus indicate the probable extent of the granite boss, so that we are enabled approximately to trace its boundary by the direction of the joints, by the scattered islets, and the soundings on the Admiralty chart; and it becomes highly probable that the original boss formed an egg-shaped mass four miles long and three miles wide.

The western portion, exposed to the full power of the Atlantic surf, has been much wasted away; while the eastern side, being more sheltered, and composed of harder granite from its contiguity with the slate, has been but little denuded.

The direction of the joints differs greatly from those of the granite of Penwith; but they agree in this, that the joints in both cases appear to have a relation to the line of junction with the slate, and that the best developed joints lie on the line of the longest axis of the granite boss.

The joints of the slate are parallel to those of the granite, and at the landing-place there is a well-defined elvan, about eight feet wide, running nearly in the same direction as the joints.

The beds of slate strike E.S.E. and dip 80 deg. N.E., thus the beds abut against the granite, where



J. Leitch & Co. Lith. 13 Bear Alley Farringdon St.

N. Whitley.

they are disturbed and sharply cut off. The slate is similar to that of the Devonian beds of North Devon.

The surface of the island, especially at its northern part, produces heath and coarse herbage. There is no well-defined soil or subsoil; but the mould which supports the heath is formed of granite detritus, mixed with peaty matter from decayed vegetation.

It is probable that at the drift period the island was swept by ocean currents, and this is supported by the fact that the shores and sea-bed adjoining abound with chalk flints and pebbles of foreign rocks.

November, 1869.

REMARKABLE SEA-WAVES,

OBSERVED IN MOUNT'S BAY, CORNWALL, APRIL 24TH, 1868.

By John Jope Rogers.

On the afternoon of Friday, the 24th of April, in this year, I was driving from Helston to Penrose, and was surprised to see the spray of the sea dashing high above the horizontal line of the Loe Bar—a bank of shingle which alone separates the waters of the Loe from those of the Atlantic.

This phenomenon is usually not observable except on the rare occasions of the heaviest south-westerly gales happening at high water of the spring tide. As the wind had been very moderate for twenty-four hours previously, from E.S.E. (*i.e.* off shore), and scarcely any wind was perceptible at the time, I left the carriage at the door, and, taking one of my boys as a companion, hastened to the Bar to ascertain the cause of so unusual a disturbance.

We arrived at the sea-shore shortly before six p.m. New moon had occurred two days before; *i.e.* on 22nd April, at eight p.m., and the time for high water on the 24th was shortly after six. This was the fourth tide after the new moon, and therefore one of the highest of that spring. A magnificent sight rewarded us. There was very little wind, even

at the shore; but the sea was a raging ocean of huge waves, such as are never seen except in the heaviest gales on that coast. We stood rivetted to the scene for nearly an hour. During the whole time, and long after high water, wave after wave beat home against parts of the cliff where I had never seen it reach before; and for the first time in my life I saw the whole line of the Loe Bar (half a mile long) frequently covered from end to end by sea waves, which poured their foaming volume into the Loe. It was not one giant wave, followed by others of less formidable bulk (as has been usually the case on occasions of volcanic disturbances of the ocean), but a succession of hundreds of great waves for more than an hour continuously, and only varied in size as is usual with the seventh or eleventh wave in ordinary tides.

The Bar had been cut during the previous winter for the purpose of setting free the swollen waters of the Loe, and the channel thus made through the shingle of the Bar had been kept open to the tide a longer time than usual, causing the scour of the tide to deepen and widen the channel to an unusual extent, leaving a deep indentation or creek on the inner shore of the Bar when it became again closed up. This deep creek was speedily filled with shingle, thrown up by the big waves; and on the following morning it was difficult to believe that there had been a channel or creek at all, so completely was all appearance of it obliterated.

Much damage was done to the coast for some

miles round the bay, the sea-waves eroding the soft earth at points rarely touched, and bringing down masses of superincumbent soil. Seeing the inroads thus made upon the coast, I began to fear for the safety of a sea-wall which had been completed at Porthleven a few months previously, but scarcely yet consolidated. We were anxious to return to Penrose by way of Porthleven, in order to see if my apprehensions were realized, but the hour and the increasing darkness warned us that we must hasten home by the shorter route. On enquiry next day, I found that my fears were justified.

The sea-wall was sixteen feet high and sixteen feet thick at the base, built of dry quarry stones, hard clay slate, set on edge, and well keyed-in together at the back, presenting a slightly concave plane towards the sea, with a vertical batter; yet the waves, repeatedly following a curved hollow offered to them by a spur of rocks jutting seawards at right angles to one end of the wall, and thus concentrating their force upon one point of attack, scooped out from that part of the foundation a hole about ten feet wide by twelve feet high, breaking up and scattering in confusion the largest stones of which the wall was formed.

I was assured by some of the oldest fishermen in Porthleven (and there are some very old ones) that they had never known such a sea with so little wind, and never but once knew the sea "come home" with such violence in a gale, *i.e.* in the winter of 1865–6.

The agitation of the sea was so continuous and

protracted that I quite expected to hear of a heavy gale in the Atlantic to account for it; but I do not remember to have heard of its being traced to such a source.

A considerable disturbance of the barometer was noticed by me on the day in question; for it fell on the 24th half an inch (to 29·25), and rebounded a full inch during the next twenty-four hours: wind on 23rd, E.S.E., wind on 25th, W.N.W.

I shall be interested to know if the observations of more accurate persons support this brief notice. I should also like to know if any signs of subsidence of the coast have been noticed in Mount's Bay during the past half century, as I am persuaded that at Porthleven the recent encroachments which the sea has made cannot be attributed to any other cause.

October 20th, 1868.

NOTES

ON THE QUARTZ REEFS, OR LODES OF SANDHURST,

VICTORIA, AUSTRALIA.

By W. Nicholas,

Member of Royal Society of Victoria.

In forwarding the following notes relating to one of the most extensive and important quartz mining districts of Victoria, I think I should commence by explaining what has prompted me so to do. It has often occurred to me that there was a great similarity in many respects between our quartz reefs and the lodes I had seen in the St. Just mining district, Cornwall. But what more forcibly drew my attention to this subject was a letter which appeared some time since in the *Cornish Telegraph* from the late much-respected Captain Truran, of Ding Dong Mine, relative to some peculiarities of lodes which he had observed, such as the sides of lodes, or some portions of them, being polished and striated, &c. I may state that exactly similar circumstances to those he mentioned occur in our reefs or quartz lodes of this district.

My object, therefore, is to give what little information I can with reference to the formation of these reefs and some of their peculiarities, believing it

possible that you might look on your lodes, in connection with our quartz reefs, from a new point of view. Should I succeed in this, if there is any analogy, there is a remote chance that some light may be thrown on their origin.

I will now proceed to give a few particulars concerning this gold-field from notes I made some years since whilst a resident there. The Bendigo gold-field is situate in what may be considered a large basin, formed by rounded hills composed of Lower Silurian clay-slates, through which run the gold-bearing quartz reefs. From the extensive denuding of these hills were derived those fabulously rich deposits of alluvial *débris*, and detritus discovered in the gullies. These gullies have been worked over and over again in a manner very similar to your streams for tin ever since the opening up of this gold-field in 1851.

The palmy days of alluvial mining have, however, passed away, and the alluvial miner now makes his £2 or £2 10s. per week only, by very hard work and long hours. The importance of this district has for many years depended increasingly on quartz mining.

Bendigo Creek, which runs through the centre of the basin above-mentioned, takes its rise near the Big Hill, one of a range of hills which run irregularly to the north-west, and is a portion of one of the many spurs thrown off from the Great Dividing Range which runs across Victoria from east to west. On this creek, and about six miles from its source, is situate the town of Sandhurst. The granite of which the Big Hill is composed is of a translucent

bluish-white quartz, very little felspar, and mica in minute particles. It is an extremely durable rock to all appearance, and has been extensively used in the construction of the railway bridges, &c., in the vicinity of Sandhurst. In comparison with the granite of Lamorna quarries, I should consider it to be much finer grained.

In the immediate neighbourhood of the granite, *i.e.* within three miles, the clay slates and sandstones are of a firmer texture than further East. The gullies have yielded many large nuggets, some of them exceeding 100 ounces in weight; in fact, the gold is generally what the miners term "shotty," or "heavy gold," and consequently is found near its original source, the finer gold having been carried farther down the valley. The quartz reefs really deserving of the name are very few, the quartz occurring as a rule in irregular spurs or veins varying from one foot down to one inch in thickness or less. Small veins, the width of which would be from about one to three inches, I have seen extremely rich, insomuch that they might be considered veins of gold rather than veins of quartz (of course, the quartz predominated); but these veins have no regularity either in their direction or continuance of gold or quartz.

From between these three miles of hard crystalline strata and Sandhurst township occurs a softer formation, in which are found some of the richest reefs of this colony, and perhaps of the world. The average bearing of the strata and reefs is 23° West of North. The outcrop of the slate and sandstone is often taken

as a guide by persons travelling in the bush. Its use in this respect is not confined to the neighbourhood of Sandhurst, but is general in a large portion of the colony. These slates and sandstones are of the Lower Silurian age, the slates containing graptolites in great abundance.

In September, 1863, I forwarded to the late Dr. Couch, for your Society, thirty-two specimens of minerals and fossils, which, I have reason to believe, were delivered. These will illustrate some of the fossils, &c., which are found on the Bendigo gold-field and in the neighbourhood of Melbourne. Among those from Sandhurst were Didymograpsus Murchisonii, D. Sextans, Diplograpsus Folium, &c.; specimens of slate and sandstones, and of the slate immediately adjoining the reef or lode; of slate and sandstone, showing the lines of deposit and lines of cleavage crossing each other; specimens of quartz; and antimony and quartz from the antimony reefs near Heathcote, about thirty-five miles South-East of Bendigo. These antimony reefs are worked for gold and antimony, the antimony being of secondary importance.

The water-level in the quartz reefs varies in depth with the rise or fall of the surface, but in the gullies it was usually met with at about seventy feet in depth. I refer to it as in the past, in consequence of the numerous pumping-engines having destroyed the original level. The water is brackish, and not fit to be used in engines.

Beneath what was the original water-level the slate

and sandstone quickly alter in colour, from the soft brown pink and muddy yellow to a dead heavy-looking grey and slaty-blue. At a depth of 200 feet, the major portion of the strata, or country, beyond a few feet from the reef, consists of an extremely hard metamorphic rock, with here and there a band of softer slate.

Both slate and sandstone in the vicinity of the reefs contain isolated cubes of iron pyrites, and frequently faces of slate of great extent are covered by them. About 50 feet east of the Johnson's Reef, and at a depth of 140 feet, there is a stratum of these cubes (size $\frac{1}{16}$ of an inch) held together, or cemented by slate, at least two feet in width. I should judge the proportion to be two-thirds iron pyrites. This is considered a good indication of the vicinity of quartz, and might be called "kindly country."

Below the water-level these cubes of pyrites are in good preservation; but above, near the surface in the lighter coloured strata, usually the only sign of their having been, is the empty cubical impression of them in the slate or sandstone, in which they have been imprisoned and have been decomposed by the ever-varying supply of moisture. Surrounding each of these empty cavities is found a red or reddish-brown stain.

In the country, or strata, the pyrites occur as a rule in isolated cubes, but in the quartz reefs it is very often observed to be massive.

Both slate and sandstone contain large quantities

of whitish mica. It is also frequently found in the cavities and laminations of the quartz reefs, and is very deceptive, from its close resemblance of gold by candle-light (underground).

The mode of testing it, made use of by the miners, is through its refractive powers. From the peculiar flat form of mica it reflects light only in one direction, whilst gold reflects the same shade on all its sides. In mining phraseology, when the substance under observation will not "stand the light," it is decided not to be gold, and any one can decide with certainty which is gold and which mica after a little practice and observation. Of course, under the light of the sun this doubt is less likely to occur, but the above remarks hold good in this case also.

Mica throws off a silvery-grey; light gold generally a deep and rich yellow; but there is also what is termed "pale gold" of a much lighter colour; and again, a third form, "ruddy-coloured gold," which appears to be coated by copper. When cut with a knife, this ruddy colour is seen not to prevail through the gold, but only on its surface.

The strata immediately adjoining the reef, on each side for about six inches in thickness, are quite altered in appearance. Above the water-level it is called the "ironstone casing," from its colour and weight. It is of a red ochre, or brick-colour, and its weight about three times that of the slate or sandstone against which it abuts. This casing is gold bearing. In former years, the early days of quartz mining, the casing of the reef was broken

separately (from the quartz), and thrown away with the mullock, or rubbish, on the burrow. The term used by the miners for breaking the casing in this manner was "stripping the reef."

This operation is always a tedious one; for it is usual to take only the outer portion, leaving about one inch standing against the quartz; this, combined with the extreme hardness of the casing, which was found to blunt the picks and gads as fast as breaking the quartz, made me often think there was little economy in separating them, although the price of crushing at that time ranged from 25s. to 35s. per ton, and the carting to the machine about 5s. more. I had another reason, and that was my having observed that between the casing and the reef (or the face of the quartz adjoining the casing) was often the richest portion of the reef, and consequently stripping the reef was a work which required either great care and judgment or a loss of much gold.

As a proof of the large amount of gold that was thrown away in this manner, I may mention that all the old mullock heaps, or burrows, which were about the shafts, have been crushed, and that they very frequently yielded handsome returns.

I think it probable that this altered slate, or casing, and the peroxide of iron which is found in such large quantities between the divisions of the quartz, have been formed by the same operation, viz., from the water percolating through the reef being laden with the decomposition of iron pyrites in the upper portions of the lode. I feel more confident in making

the above statement with reference to the formation of the peroxide of iron, from having observed in a level through which water from a reef had been flowing undisturbed for many months, that the portions of slate over which the water had passed were covered by a red deposit of about the eighth of an inch in thickness, and that this deposit had, I might almost say, precisely the same flowing lines as those so commonly found in the peroxide of iron formed in the natural divisions of quartz reef, the only apparent difference in the lines being that those deposited in the level were less waved. This, no doubt, would be caused by the greater strength and power of the constant stream flowing over them.

Below the water-level the iron-stone casing disappears, or is changed into a soft black clay-slate, frequently containing brilliantly-polished faces, which, on being rubbed, stain the finger in a somewhat similar manner toplumbago. I have seen miners, who had been working in this casing, look almost as black as they would have if they had been working in coal.

Quartz reefs, I may say, are entirely formed of quartz; the quantities of iron pyrites, galena, manganese, felspar, mica, and gold, &c., contained in them bearing but a very small proportion to it. And more especially the latter-mentioned article—gold, for I never heard of any miner grumbling at its excess, although it has been found in what I have heard Cornishmen call "great thuds." The gold that called forth this remark was found in the Energetic

Claim, North Victoria Reef, just about the original water-level, and the greater portion of it was covered by a coating of peroxide of iron. The gold in this case occurred in the cavities of the natural division of the quartz.

The common term expressive of the shape of the upper portion of a reef is "saddle-formed." Reefs vary very much in their width, but the average of the principal and most permanent ones is about three feet.

Quartz in the cap of a reef I have known to exceed 23 feet in thickness, and to be of sufficient richness to work the whole of it (in Latham and Watson's claim, Hustler's Reef).

On the Victoria Reef, in the old Albert Company's claim, I saw a cross-cut driven through a body of quartz, which I measured to be between 60 and 70 feet in thickness, from one wall or casing to the other. This large body of quartz was very coarse and poor, no portion of it being payable. I have no doubt that it was the cap of the eastern and western Victoria Reefs, two of the richest reefs in this district.

"Quartz boils," as the miners term them, of nearly as vast a size, are, or were, to be seen on the New Chum Reef, the Windmill Hill, the Sheepshead, the Hustlers, and many others, but have been found to be too poor to work; only occasionally have the two or three feet next the casing been found to be payable. The Victoria Reef attained an immense width in the Endeavour Company's Claim at 200 feet in depth, being 40 feet in thickness. The average yield of

gold for this width was one ounce per ton, but this is an exceptional instance.

The back of the reef (behind the casing) as a rule we find to be formed of sandstone and the footwall of slate. The back frequently presents the appearance of having been water-worn, just like the smooth faces of the rocks on a sea-shore.

The quartz about the cap of a reef has no regular structure, but it is merely a great mass of hungry-looking quartz, containing but little gold or any mineral; yet as we get deeper and farther away from the saddle of the reef, the quartz decreases in width and assumes a laminated formation.

The laminæ run parallel to the walls of the reef. On fracturing a piece of quartz with one of these faces, it would, as a rule, be found to be partly covered by slate, iron pyrites, galena, and gold.

Galena appears to be a most kindly mineral for gold; for most rare is the instance of any reef containing it, which is not found to contain gold, and that, too, in payable quantities. This remark will, I believe, apply to all the reefs of this colony.

It is a generally received idea that all reefs containing iron pyrites contain gold, and I do not believe there is one reef in which iron pyrites are not to be found; consequently, all our reefs are auriferous, and no doubt they are; but unfortunately a few solitary specs of gold, or cubes of iron pyrites, will not make a payable reef.

Experience goes to prove that the richer the reef is in minerals the richer it is in gold, and *vice versâ.*

It is a common circumstance to find gold intimately associated with iron pyrites and galena for the very best of reasons; viz., that by far the largest quantities of these minerals are found to occur in the laminations. I have often seen gold and pyrites so mixed that I could not discern where the junction was. Auriferous pyrites sometimes so nearly assume the colour of gold that at a glance one is apt to say that it is pure gold, but on closer inspection the difference is easily observable; for it presents too brassy a look. At the same time, pyrites and gold seem to stare at you from the same spot, separately, and yet in one. In a specimen contained in the auriferous quartz collection of the Mining Department of Victoria there is a cube of decomposing pyrites of a dark colour, through which traverse tiny veins of gold distinctly visible to the naked eye. This specimen is No. 266, and is described in the catalogue presented to your Society. It was extracted from the Victoria Reef, Sandhurst, at a depth of 200 feet, the depth of the water-level being 150 feet.

I have very often seen gold traversing galena in a similar manner to the instance above referred to. This is owing more, no doubt, to the greater difference between the colours of galena and gold than in pyrites and gold, and not to its being more frequently the case.

Perhaps the best proof I can give you, in lieu of the specimens themselves, in corroboration of the correctness of some of my statements, will be to refer you to the catalogue (which I have already cited) of

auriferous specimens in the collection exhibited by the Mining Department of Victoria at the late Intercolonial Exhibition, held in Melbourne in 1866 and 1867. In this catalogue you will find specimens of quartz from all the important reefs and gold-fields of this colony described, together with a large amount of valuable information which has been collected by the mining surveyors and registrars' officers of the department, under the direction of Mr. R. Brough Smyth, Secretary for Mines, Melbourne.

The general strike of the reefs is northerly. At nearly right angles to the strike, both the quartz laminations and casing are striated, caused apparently by a gradual motion and attrition of the strata. These lines do not show themselves in isolated spots only, but generally throughout the reefs.

They are well marked, and run in an uniform direction, as above stated. In no case have I observed these lines more distinctly displayed than in the Williamson's Reef—a thin, small, but most regular reef. Where the quartz had been reduced to between two and three inches in thickness, it was composed of what might be called corrugated quartz. The laminations were only about the sixth of an inch distant from each other. This peculiarity I found to obtain for over 200 feet in length, and it gave the reef the appearance of having been deposited in a like manner to the adjacent strata.

Of course, this quartz would naturally fracture with its laminations; and when so broken, it presented a dry, unkindly, pale appearance, possessing

no minerals or variations in colour. I need hardly say that we found no gold in the reef whilst it retained these characteristics. But in the short length of twelve feet it would burst out into a width of about three feet, composed of a pure white, fine, rubbly, and unlaminated quartz, containing the usual minerals, and yielding as much as twelve ounces of gold per ton. This reef was most regular in its bearing and underlie (eastern).

West of the Williamson's Reef is the Sophia (western underlie), which proved to be rich, the first crushing from it yielding over ten ounces of gold to the ton, but I never saw a more wayward vein. The strike of this reef was northerly, and about two feet in six feet. This could be most distinctly seen, in consequence of the reef taking a sudden bend, and running off to the west in an undulating, graceful manner, not much admired, as you may readily conceive by the mining manager, when I tell you that with every wave it decreased both in size and richness, as if bowing itself out of sight, which it eventually did in the roof of the drive put in to follow it. Whether it went away to surface again I never knew, nor am I aware that it was ever tested in its vagaries any farther than when last seen by the then manager, whom I may perhaps just as well inform you was myself. The back of this reef, as is usually the case, was composed of sandstone. Between the sandstone and the casing we found a little highly-polished slate. The sandstone was irregularly rounded and very smooth, and looked as if it had at

one time been exposed to the wearing influences of water. When the reef ran away flat, it carried the sandstone with the margin of slate still on its back. In the contorted portion of its course the quartz was thickest, and richest, in the bollows of the bends; in fact, they seemed like small inverted gutters.* The lines of deposit in the slate of the footwall followed, or ran parallel with, the undulations of the quartz line for line with wonderful accuracy. I am enabled to state this from the circumstance of this being the first instance in which I saw clearly the planes of cleavage running at right angles to the lines of deposit. (These lines were most distinctly and beautifully defined, in consequence of the strata being composed of thin layers of a very dark blue and a white slate.) I, therefore, paid very minute attention to everything connected with the reef and the strata in its vicinity, making it as much as two or three visits daily, in order that I might see the slate adjacent to the quartz as it appeared freshly broken. This slate contained a fair sprinkling of very bright and perfect cubes of iron pyrites of uniform size, being nearly the sixteenth of an inch square.

I have found felspar in the Victoria reefs, and have in my collection the best specimen of it that I have as yet seen. In this specimen fine crystals of felspar occur on a crystalline face of quartz. I had a very beautiful specimen of small delicate crystals of fel-

* The name given to the deepest and richest portion of auriferous alluvial deposits.

spar held together by gold, which was found in the same reef. This was the only instance in which I ever saw gold in felspar.

I have noticed in the Johnson's Reef that where the reef ran out in a wedge-like form, its place between the walls of the reef was supplied by a formation of slate, very thickly studded with fine cubical pyrites, until the quartz again forms and takes up its rightful position.

A similar formation to the above occurs in the Great Extended Coy's mine at Eaglehawk, which has proved to be very rich, yielding by the ordinary method of crushing alone as much as 5 ozs. 12 dwts. 12 grs. of gold per ton. On the Johnson's Reef the formation showed evidence of being laminated, as if it had been deposited in a similar manner to slate: the laminations were parallel to the strata on each side.

The lava-streaks (local name) or dykes present us with some of the most singular features in connection with quartz mining. They are composed of a soft amorphous clay, and have a dioritic appearance. They vary much in colour, from a dull, heavy, absorbent brown to a bright yellow or green, the yellow often forming a band on each side of the brown centre. Both the yellow and green I have often found to be striated, and to have polished faces. They consequently have the appearance of being partially laminated, but are not so in reality.

On all the main lines of reefs these lava-streaks have been met with, but are rarely welcomed; for at

their junction with the reef they materially affect it, either by cutting off the quartz abruptly or by destroying its regularity, and rendering it thin, poor, dry, hungry-looking, and much mixed with foreign matter.

In an oval shaft, sunk on a lava-streak on the Victoria Reef, I observed that, through the lava being softer than the adjacent strata, it had crumbled away; that permitting its tortuous course, as it ran across the shaft, and back again, in about every 20 feet of depth, to be distinctly seen.

But the general direction it observed, *i.e.* its underlie, if I may so call it, was very true. At the surface this lava-streak entered the shaft on the western side, making its exit out of the shaft on the eastern side at about 170 feet in depth. At 200 feet in depth it intersected the reef, and completely destroyed what had up to that time been a well-defined rich reef of from two to three feet in thickness.

On the Johnson's Reef a lava-streak, underlying west, cut out one reef at the top, and, at a greater depth, another at the bottom. I thought it very probable that these so-called separate reefs were originally one and the same, which had been displaced at the time of the intrusion of the dyke, or lava-streak; but this is merely conjecture; for I had not, at the time of my visit, any leisure to examine this interesting fault. At a still greater depth, on the course of this lava-streak which was sunk on for communication between two levels, it was found that a number of quartz spurs, underlying east, intersected it, and formed a large reef on its

back, and thus accompanied the lava-streak on its course as deep as it was then prospected. This last feature rendered these lava-streaks more incomprehensible to me than ever. They certainly appear to have a very close connection with quartz reefs, and, from my experience of them, may be followed as infallible guides to the reefs, which at the same time would afford very easy sinking.

The contour of the hills of this district can, I believe, be accounted for by the form of the quartz reefs. Viewed from the north or south, they are rounded and almost always gently sloping. From the east or west they may, in a measure, be considered to be serrated, or saw-formed. Each hill has a length or breadth, the bearing of the length being similar to that of the reefs, about 50° west of north the slopes from the summit to the north being very gradual; whilst to the south, in comparison, they are abrupt and precipitous. You will observe in the longitudinal sketch-section of reefs forwarded herewith that they have a general strike to the north. On the tops of the north slope of the hills the quartz reefs are generally found to crop out on the surface, and, as a natural consequence, being harder than the country in which they are situate, offer greater resistance to the denuding elements. On those ranges in which the quartz does not crop out, as a rule there will be found the ironstone casing or "burnt sandstone" of the miners, which is extremely hard, and offers just as much resistance to denudation as the quartz itself.

From the top of the hills to the south the "crown" or "cap of the reef" is broken through, and the strata, or country beneath it, is exposed without any protecting cap, and so is the more readily acted on, and presents a bolder declivity.

In the early days of this gold-field, before quartz mining was commenced, fine tors, or immense bodies of quartz, occupied the summit of nearly all the hills, and must naturally have added very much to the picturesque appearance of the then wooded country. And as the face of the country got cleared of the timber, they must have stood more boldly out, breaking that smooth, even rounded, appearance which the hills now have. I am informed, from reliable sources, that in those early days when quartz mining was not dreamt of by the majority, it was the usual pastime of the diggers on Sundays to take hammers, go up to these beautiful outcrops, in most of which gold could be seen, and break out specimens.

The only remarkable one of these which I recollect stood out on the north side of New Chum Gully. The sole reason of its not having vanished like the others before the advance of the Anglo-Saxon race must have been its exceeding poverty. I have often watched it, when passing near, with a jealous eye, fearing that some speculative miner would, notwithstanding its poverty, be sufficiently enterprising to peg off the ground on which it stood, and eventually destroy the last of the race of quartz outcrops left on this field. But it was destined to be placed on "the roads"—a rather ignominous term in this colony;

and I must own I was sorry indeed to find that such was to be the case. On the morning of the 26th August, 1862, to my surprise, I found some men had commenced boring operations, prior to blasting the quartz; they proved to be road-contractors, who were about to make my old friend into road metal, and, as I could not prevent them doing so, I decided on doing the next best thing, viz., making a sketch of it as it then stood. At the present time there is scarcely a vestige of it left. Its dimensions, as roughly measured by myself, were—height, 20 feet; length, 36 feet; width, 4 feet 6 inches; underlie east, about 1 foot 6 inches in 6 feet. These outcrops were slight evidences of the immense denudation the face of this district has suffered in past ages.

In bringing this paper to a conclusion, I would beg to draw your attention again briefly to the facts before stated, that all our reefs in this district are of a laminated structure, *i.e.* a little below the cap of the reef; that in these laminæ most of the gold and minerals are found, in addition to slate, mica, and sometimes felspar, and that it is my belief that such is the case throughout the reefs of Victoria. (In making this remark it will be as well that I should state, that although my experience of quartz mining has been gained in the Sandhurst district, I have examined and described good average quartz specimens from every other mining district in this colony.)

The reefs of the Sandhurst district run parallel to the adjacent strata, and the upper portion of every

reef terminates in a cap, or, I believe, did so prior to its being denuded of it, so their formation has the appearance of an inverted V. At more or less distance, directly beneath the upper reef, another occurs, so far as I have observed, totally distinct and separate from one another, and this supposition holds good to the greatest depths as yet proved in this district.

The quartz of nearly every reef is striated in its laminæ, or on its sides.

The slate and sandstone adjoining the reefs (and sometimes the reef itself) have, more or less, polished sides. These phenomena appear to be evidences of a consistent and regular movement in the strata in which our quartz reefs are situate.

I may state that I am a mere gatherer of such facts as are presented to you, holding no special theory or theories of my own on the formation of quartz reefs.

MEMORANDUM ON

THE DISCOVERY OF HAZEL-NUTS IN TIN STREAM AT ST. HILARY.

By Thomas Cornish.

Early in December last some hazel-nuts, in excellent preservation, were found, about 18 feet below the surface, in Tregilso stream-works, in Saint Hilary. The formation of the ground in the stream-works is described by workmen employed in it as

Surface Mould,
Clay,
"Rab," "Shingle," "Run," or
Water-worn Stone,
"Turfy," qy. Peat,
Stream Tin Stuff.

The nuts were found in the "turfy" formation.

This stream-work lies in the valley between Hayle Estuary and Marazion Marsh.

The workman who found the nuts, and gave the above information, states that some few years ago he worked in a stream-work near Wheal Darlington, in the same valley as the first, and about a mile west of it (the pit with the remains of an engine on it south of the railway, about half a mile east of Marazion Station) the formation there was—

Marsh surface,
"Turfy," qy. "Peat" soil,
Sand, mixed with small white shells in great numbers, but mostly much injured,
"Turfy," qy. "Peat" soil,
Tin stream.

In the lower "turfy" or "peat" soil were found nuts and quantities of some hard wood.

October, 1870.

NOTE ON

CHROME IRON IN THE SERPENTINE OF THE LIZARD.

By Richard Pearce, F.G.S.

In the summer of 1862 I observed in several lumps of serpentine which I examined small granular particles of a black, hard mineral, which proved to be chrome iron.

I am not aware that the occurrence of this mineral in the Lizard serpentine has been noticed before by mineralogists, although I can hardly imagine that it has escaped the observation of those who have minutely studied the mineralogical characters of the rocks in that district.

The books on mineralogy which I possess make no reference to Cornwall as a locality for chromite, and I have thought that it might not be out of place

for me to ask the Geological Society to notice it in their *Transactions*.

The specimen which accompanies this paper I found in a quarry near Cadgwith. I have thought it of sufficient interest to estimate the quantity of chrome iron contained in the stone; it amounts to 1·80 per cent. An analysis of the sample, contained in small tube, yielded 30 per cent. of sesqui-oxide of chromium, which represents 39·3 per cent. chromic acid.

In addition to the ordinary constituents of chrome iron, I detected a trace of copper equal to about 0·10 per cent.

Minute particles of iron pyrites were also visible by the aid of a lens.

October, 1870.

NOTE ON A GRANITE BLOCK AT HALAMANNING.

By Richard James.

About twelve years since, whilst inspecting the Halamanning mines, in the parish of St. Hilary, in company with one of the resident agents, I had my attention drawn to what I considered a most curious phenomenon. At about sixty fathoms from surface, in sinking a winze from one level to another, they had suddenly met with a large block of granite, very much in the shape of a bullock, but much *larger*, and imbedded in the killas, in which strata this mine was entirely worked; in fact, there is no granite occurring in its neighbourhood nearer than the Godolphin Hill, in Breage, on the east at about the distance of a mile and a half, and St. Michael's Mount on the west also about one mile and a half distant. I have been asked whether this block was not perhaps a cropping-up of the granite formation from below the killas, which has occurred in some of the mines in the Camborne and Redruth districts, at the junction of what they term the North and South Granites. But this I conclude was not the case, as the granite bed must be hundreds of fathoms below the point at which this curious block occurred. In the course of conversation a short time since with a

gentleman who is deeply interested in all that concerns the geological formation of this county, he deemed it advisable that I should communicate the occurrence to this society, thinking that perhaps some of its members might be able to throw some light on this matter as to the formation.

October, 1870.

MEMORANDUM ON PITCHBLENDE IN COLORADO.

By Richard Pearce, F.G.S.

I have sent for the Geological Society a specimen of pitchblende (oxide of uranium), which I discovered a few weeks ago in Russel District, Gilpin County, Colorado Territory.

It is the first time, I believe, that the mineral has been found in America.

It occurs associated with auriferous copper and iron pyrites at the junction of gneiss and mica schist.

I found about 2 cwt., which had been thrown away on the refuse-heap, and the person in charge of the property told me that it caused them a great deal of inconvenience, as it had come into the lode and cut the copper out. You may imagine his surprise when I told him it was worth in England about £400 per ton!

Morfa Works, Swansea,
October 27th, 1871.

NOTE ON PITCHBLENDE IN CORNWALL.

By Richard Pearce, F.G.S.

The recent discovery of pitchblende at Wheal Owles, St. Just, is interesting, as affording a new locality for this mineral; and I have no doubt the Society has already been favoured with particulars of its occurrence in that district.

I am induced to offer a few remarks relative to the conditions under which this mineral has been found in Cornwall.

Pitchblende almost invariably occurs associated with other rare Cornish minerals, and the laws which appear to regulate its deposit in various localities are strikingly analogous.

At St. Austell Consols it was found with nickel and cobalt ores, and a quantity of this valuable mineral was sold as an ore of uranium.

At Dolcoath, where I found it in 1859, it was associated with native bismuth and arsenical cobalt in a matrix of red compact quartz and purple fluor spar.

At South Tresavean I discovered it in 1863 with kupfer-nickel, native silver, and rich argentiferous galena.

I believe in all the localities I have named it was found in little veins crossing the lodes.

The St. Just pitchblende, however, so far as I have been able to ascertain, does not occur under similar conditions to those I have before named. I have found, however, traces of lead and silver in the Wheal Owles mineral.

In the specimen which Mr. Boyns was kind enough to send me, I find the physical characters differ somewhat from pitchblende found in other localities in the county. The colour is reddish-brown; structure, somewhat lamellar; specific gravity, 4·95.

The peculiar grouping of certain minerals, and their relation to the rocks in which they occur, is a subject meriting more attention than it has hitherto received from English mineralogists, and no better field than Cornwall can be found for study in this particular direction.

ON TRACES OF GLACIAL ACTION ON THE GREAT CAIRN, NEAR GORRAN HAVEN,

CORNWALL.

By C. W. Peach, A.L.S.

At the meeting of your society in October, 1848, a paper of mine was read *On the Geology of Part of the Parish of Gorran, Cornwall*, and was afterwards printed in vol. vi. of your *Transactions*. At page 56 mention is made of the "slickensides" on the large blocks of quartz rock at the Great Cairn, and that "some pieces from the highest point were as highly polished as if done by a lapidary." Those pieces I have great pleasure in sending with this for your inspection and acceptance for your museum. They are all I have, and were got out with difficulty, owing to the extreme hardness of the rock. They were broken from the *horizontal* face of the upper mass which crowns the pile that shows so conspicuously in the cliff above Peraver. Although a small sample, it is highly characteristic, not only of the rock itself, but shows well the polishing by glacial action, and to those conversant with such polishing cannot be mistaken for slickensides. When I lived in Cornwall I knew nothing practically of the appearance of glacial action; had I, it is probable I might have done better.

Even at that time I was so much interested in seeing the quartz blocks scattered far and wide, that at pp. 56 and 57 of my paper they are particularly noticed, and the places where they lay, although I was unable to say how they had been dispersed. It would be well if some one would examine them, and the deposits of stone and clay-matter in the cliff on the side of the stream that flows through Gorran Haven, and as well the deposit of blue clay at the back of the fort near the place. In all probability polished and striated stones would be got in these localities, showing glacial markings.

When in your county, in 1869, I visited St. Keverne, to try to find the Porthalla limestone. Unfortunately, the wet weather was against me. Despite of this, I devoted as much time as I could spare to examine the pile of quartz rocks under the Nare Point. Slickensides was there, like that of Gorran Haven, and also scattered blocks, but no polished surface. All around for miles the wide-spread ruin of former rock deposits might be seen, blocks of all sizes lying thickly. To me they prove that ice only could have removed them and laid them where they are. Atmospheric influences have acted on them, and lichens have grown on them; and thus all the markings of transportation and grinding are lost. Lichens would also cover markings on most of the quartz blocks. The only way to get at fresh markings would be by turning up some of the imbedded rocks and examining the underside, as well as the upperside of rocks when bared of their protecting

covering of earth and grass, whether for quarrying or other purposes. By this method I have been fortunate enough to find traces where those on the exposed surfaces had been lost.

With the polished specimen from the Great Cairn I send one of quartz rock for comparison, taken from a huge mass near Eriboll House, on the side of Loch Eriboll, Sutherlandshire, in 1857. You will see that the polishing is much alike in both, and I feel no hesitation in stating that both were done by glacial action. That from Sutherland shows it best; it evidently was exposed and acted on by long-continued heavy glaciers; for all the surroundings show how powerful and extensive they must have been, both by the wide-spread ruin and extensive scratching and polishing seen for miles. On the other side of Loch Eriboll rises Ben Spionnu, 2,566 feet above the level of the sea. The quartz rock slopes from the top to the bottom of this mountain into Loch Eriboll, passing under the limestone island in it, and rises again in the hill on the House of Eriboll side of the Loch, and is there again covered by limestone from the Loch side to the spot where it shows itself nearly vertical on the hillside. The quartz rock on the side of Ben Spionnu has been grooved and polished in the most surprising manner at more than 1,000 feet up its side. I have followed it for hundreds of feet, from ruts deep enough to hold your fingers, up to the highest polish, some of it brighter than that sent from near Eriboll House. This polishing is not vertical, but horizontal. Seen

from a distant hill when the sun shines on it the rays glitter as if
glass.

Although non-gl
the quartz rock of
identical with thos
Peraver, and which
" a *coral* very much
The likeness to th
ever, I know now
they were made b
It is thus interesti
quartz rocks cont
colites; it further
also found in the
stones, Shropshire
colites are in you
troubling you wit
has been written
glad that Mr. V
subject, and I h
delighted to be a

The reason t
your possession
short time ago,
amongst other Cornish things packed before I left for Scotland. I trust it will prove worthy of acceptance.

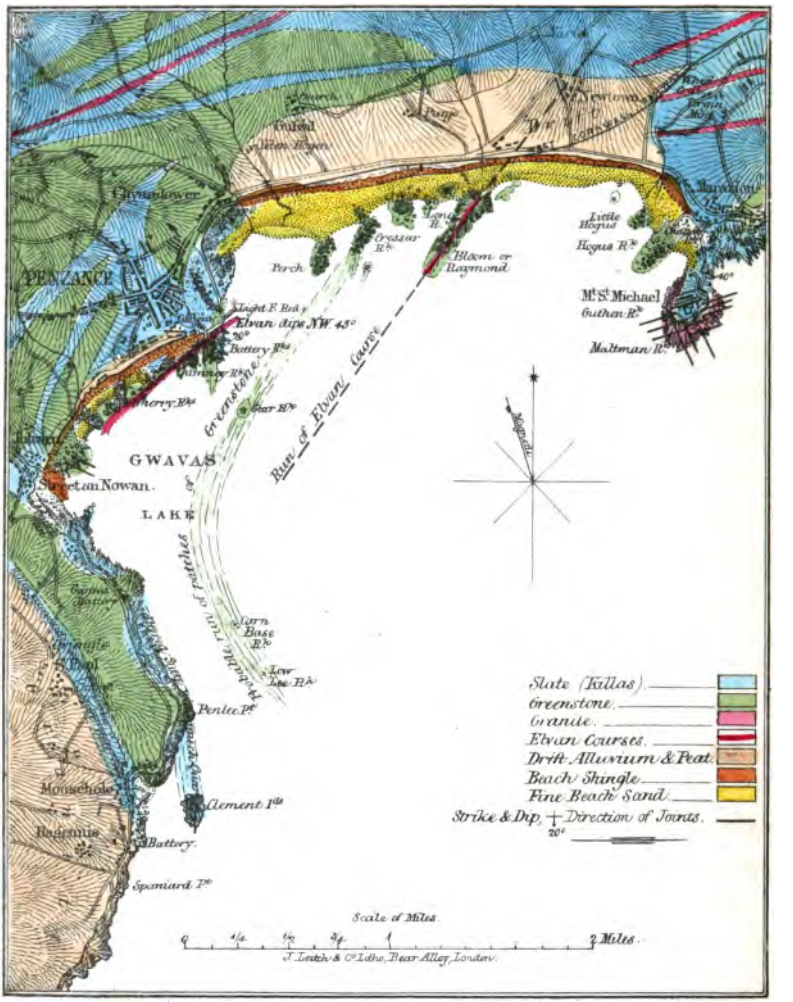
HADDINGTON PLACE, EDINBURGH,
30th October, 1871.

from a distant hill when the sun shines on it, the rays glitter as if striking upon acres of polished glass.

Although non-glacial, I cannot resist saying that the quartz rock of Sutherland is full of *arenicolites*, identical with those I found in the quartz at Great Peraver, and which at page 57 of my paper I called "a *coral* very much like the recent *sabellaria alveolata*." The likeness to these sandy tubes is complete. However, I know now that they are not coral, and that they were made by the annelide above mentioned. It is thus interesting to know that these two silurian quartz rocks contain similar organisms; viz., *arenicolites;* it further adds to the interest that they are also found in the silurian quartz rock of the Stiper stones, Shropshire. Specimens of the Cornish arenicolites are in your collection. I must apologise for troubling you with this trifle; my excuse is, so little has been written on Cornish glaciers. I am, however, glad that Mr. Whitley has so ably taken up the subject, and I hope he will go on. I should be delighted to be a fellow-worker with him.

The reason the specimen now sent was not in your possession long since is, it turned up only a short time ago, after more than twenty years' repose amongst other Cornish things packed before I left for Scotland. I trust it will prove worthy of acceptance.

HADDINGTON PLACE, EDINBURGH,
30*th October*, 1871.


PENZANCE
Chyandower
Perch
Grossar R.
Bloom or Raymond
Little Hogus
Hogus R.
Mt. St. Michael
Guthen R.
Maltman R.
Light F. Bat.
Elvan dips NW. 45°
20°
Battery
Gear R.
Greenstone
Run of Elvan Course
GWAVAS
LAKE
Sheet an Nowan
Granite Pool
Lorn Base R.
Low Lne R.
Penlee Pt.
Mousehole
Clement Pt.
Battery
Spaniard Pt.
Slate (Killas)
Greenstone
Granite
Elvan Courses
Drift Alluvium & Peat
Beach Shingle
Fine Beach Sand
Strike & Dip, + Direction of Joints.
20°
Scale of Miles.
0 1/4 1/2 3/4 1 2 Miles.
J. Leitch & Co. 1 the, Bear Alley, London.

THE GEOLOGY OF PENZANCE BAY

AND ITS SHORES.

By Nicholas Whitley,
Honorary Member of the Society.

The long and rugged coast-line of Cornwall presents favourable opportunities for the study of its geological structure, and nowhere are more interesting sections exposed by the abrasion of the sea than around the Bay of Penzance.

From a survey of its shores at low-water, and an inspection of the seaward rocks by boat, I have constructed the accompanying map, showing the position of the rocks, their strike, dip, and the direction of the joints. The structure of the country inland is taken from the Ordnance Survey.

I purpose only to make some general remarks on the geological features of the Bay, without entering on details, and to draw such inferences as the facts appear to suggest.

It will be seen from the map, that at the N.E. of the Bay the beds of slate and greenstone run S.W. The smaller patches of greenstone are clearly seen to be bedded in the slate, on the same line of strike; and the larger bosses of greenstone partake of the same general direction. Westward to Penzance, and

southward to Mousehole, these beds curve with the shore of the Bay, and run parallel with the edge of the granite behind them. In some places the greenstone passes into hornblende slate, and the whole mass appears to be contemporaneous with the slate in which it is bedded; in other places the junction of the two rocks is well defined, and the slate is twisted both in strike and dip by the greenstone. These massive hornblende rocks which skirt the Bay—which have governed its outline, and have given fertility to the soil on its slopes—form part of that extensive and ancient outburst of volcanic matter, the ashes of which now form beds of trappean conglomerate among the Devonian slate, and its more compact parts, the greenstone bosses, which circle around the afterwards erupted granite, or cap the headlands of our coast.

But the geological history of the Bay centres rather in modern than in ancient periods; and there are records written on its shores which cast some light on the changes through which it has passed. But, dwelling for a moment on its ancient form, the solid ground of Devonian slate and hornblende rock must have extended further than at present into the Bay, and perhaps far beyond it. The now naked elvan courses and the exposed trap-rocks must have been coated with thick beds of slate when they were erupted. The Gear was once a portion of the mainland, and the Long Rock and the Cressars were clothed with beds of slate long, long before their more fragile covering was devoured by the sea. The

trap-rocks, from Cudden Point to the Greeb, are four patches of the tail-ends of beds which once extended far across the entrance of the Bay.

But the modern deposit of drift inside the Eastern Green indicates a period of greater interest. The drift is exposed in the railway cutting near Wheal Darlington Mine, and in many open pits around it forms a tongue of land extending into the valley, and may be traced to New Town and beyond. It is composed of water-worn pebbles of quartz, elvan, granite, greenstone, altered slate, and some water-worn chalk flints, and covered with a soil, the ruin of the adjacent land above, at the base of which is some angular *detritus*, crushed quartz being the most abundant, and shattered flints and flakes. In an uncultivated croft adjoining the new turnpike-road, denuded of the upper covering of the soil, the crushed flints and flakes may be found on the surface mixed with broken quartz.

These beds of drift correspond in every respect with the so-called "raised beaches" which are found in patches clinging to the ancient shore-line of the Bay, a section of which has been lately exposed in excavating for building at and near the Penzance gas-works, where water-worn pebbles and fine siliceous sand form a *stratum* at the base from 2 to 3 feet thick, covered with 20 feet of clay and loam, mixed with *angular* rocks of greenstone from the hill above, from a few inches to 8 or 10 feet across. These beds are stamped with all the geological elements which constitute the drift period.

Water-worn pebbles of local rocks are mixed with foreign materials, and covered with a confused mass of clay and angular rocks, pitched in at all angles, some so large that only ice action could have torn them from their native bed and lodged them in the confused mass of clay and stone in which they are now found.

The drift at Wheal Darlington obviously came down the valley towards Hayle, and over its low-water parting; and I have traced backwards the trail of similar beds from the Scilly Isles, along the north coasts of Cornwall and Devon to South Wales. They are also found on the west coast of Wales, on the Isle of Man, and over the county of Down, up to their native site in Antrim. The pieces of basalt, "white limestone," and baked flints, stamp a character on these drift beds which make their identity unmistakable. On the east coast of Ireland this Antrim drift may also be traced as far South as Cork.

How far these beds extended seaward cannot now be determined. That they filled the whole of Penzance Bay appears certain from the patches which remain along the shore, and it is probable that they extended far beyond, if not quite across the English Channel. And here I would notice the instructive fact, that, on examining the greenstone rocks of the Great Hogus, which extend far out into the Bay, I found the remains of the loamy subsoil, with angular stones, at about the half-tide level, and similar to that on the mainland.

On these beds of drift, which once choked up the

Bay, grew the ancient forest, the remains of which are now found below the sea-level at Lariggan and near Marazion, and described in the *Transactions* of the Society. The last movement of the land appears to have been downward, and, as it sank, the sea excavated the Bay, leaving patches of drift clinging to its shores, and throwing up the shingle and sand at the Greens, which now protect for a time the portions of the drift-beds behind them.

November 3rd, 1871.

ON THE BONES OF A WHALE FOUND AT PENTUAN,

NOW IN THE MUSEUM OF THE ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

By William Henry Flower, F.R.S.,

Hunterian Professor of Comparative Anatomy, and Conservator of the Museum of the Royal College of Surgeons of England.

The fourth volume of the *Transactions* of the Royal Geological Society of Cornwall contains a paper (read October, 1829) by the late Mr. J. W. Colenso, entitled, "A Description of Happy-Union Tin Stream-work at Pentuan." Reference is there made to certain organic remains found at various depths in the works, and which were presented by the author of the paper to the Society, and are now contained in the Museum at Penzance. Among these are several bones rightly identified at the time as having belonged to "a large whale," an account of which it is my object to give in the present communication, as I believe they have never been described, and the species to which they belong has not hitherto been determined.

For the particular circumstances under which the bones were discovered, which are of very considerable geological interest, I must refer to Mr. Colenso's paper. I may, however, mention that the works

were some half-mile or more from the present sea-shore, and about sixty feet in depth, the greater part of which is below the sea level, and that the whale bones were found at a depth of rather more than twenty feet from the surface in a stratum of sea sand, above which was a bed of rough river sand mixed with gravel, and below were several distinct layers of sea sand and silt, containing timber trees, chiefly oaks; remains of various animals, as red deer, oxen, and boar; human skulls (one of which is now in the Museum), a piece of oak fashioned by human agency; and lower down, stumps of trees *in situ*, moss, leaves, hazel-nuts, &c.; still further down being the tin ground, lying on hard rock composed of blue killas, and on account of which the works were undertaken.

These conditions clearly indicate that at one period the spot was dry land, and the site of a forest; that it subsequently became submerged to a considerable depth below the sea, at which time the whale would have been stranded; and that it has since been restored to dry land, either by a re-elevation or by the accumulation of sand driven up by the sea, together with gravel washed down from the neighbouring hills. As to the date of the whale's stranding, I will not venture to offer a conjecture; but the evidence appears conclusive as to its having been subsequent to the occupation of the country by man and recent animals, as the red deer, but so long back as to have allowed of the accumulation of upwards of twenty feet of sand and gravel above it.

The bones mentioned by Mr. Colenso, all of which are now in the Museum, are: 1, the right ramus of the mandible, or lower jaw; 2, a lumbar vertebra; 3, a humerus; 4, a radius; 5 and 6, two metacarpals, or phalanges. There is every reason to suppose that they belong to the same individual, and are in much the same condition, being nearly white, as if bleached by exposure on the beach, entirely free from oil, which so strongly pervades all recent whale's bones, heavy and dense in texture, though not in any way mineralized. They are thus quite different in appearonce from the human and animal remains which were found below them, and which all have the characteristic deep brown colour, resulting from contact with decomposing vegetable matters.

The animal had probably attained its full size, though it was not old, as the epiphyses were united at both ends of the humerus, though traces of their original separation remained, and both of the disk-like terminal epiphyses of the body of the vertebra were absent.

It is perfectly evident that they belong to no species of whale known to exist in the British seas; indeed, the peculiar form of the jaw and the proportions of the other bones are different to those of any species of whale described, with one exception, and that is one of which a skeleton was found, under circumstances in some respects similar to the present one, in the Swedish island of Gräsö, in the Baltic. In that case, fortunately, the skeleton was far more complete than in the present instance, and as all the

bones have been excellently described and figured by Professor Lilljeborg, of Upsala,* there is no difficulty in making a satisfactory comparison. This specimen was found in draining a field, where the bones lay partly in sand and partly in clay, at a depth of two to four feet, ten or fifteen feet above the present sea-level, and eight hundred and forty feet from the shore, and in conjunction with the shells of *Mytilus edulis* and *Tellina baltica* of precisely the same appearance as those now met with in the Baltic, indicating a period when the general physical features of the sea were as now, but anterior to the elevation of the island to its present level. The length of the entire skeleton was estimated at between forty-five and fifty feet. It was originally described by Professor Lilljeborg under the name of *Balænoptera robusta*, but it afterwards constituted the type of Dr. Gray's genus *Eschrichtius*,† which designation has been adopted by Lilljeborg in his more recent and detailed memoir above referred to. The following comparison of the dimensions and characters of the bones of the two specimens will show the grounds upon which I infer their specific identity. It will be observed that the Cornish specimen is throughour slightly inferior in size to that from the Baltic:

---

* *On two sub-fossil Whales discovered in Sweden. Nova Acta* of the Royal Society of Sciences at Upsala, ser. 3. vol. vi. 1867. Also *Ofversigt af Skandinaviens Hvaldjur* (Upsala Universitets Arsskrift, 1861-2); translated into English in *Recent Memoirs on the Cetacea*, published by the Ray Society, 1866.

† *Annals and Magazine of Natural History*, vol. xiv. p. 343.

RAMUS OF MANDIBLE.	Pentuan ft.	Pentuan in.	Gräsö ft.	Gräsö in.*
Length in straight line	7	6	8	2
Height at condyle	1	2½	1	5
Height at coronoid process	0	10	0	11
Height at middle	0	10	0	10½

The bone is remarkable for its massiveness and great vertical depth, which is pretty nearly equal (about ten inches) for the larger part of its extent. The condyle is large, and separated by a deep horizontal groove, on the inner side only, from the prominent angle. The coronoid process is represented only by a low nodule, the anterior edge of which is twenty-four inches distant from the hinder end of the bone. Near the upper edge of the outer surface are seen seven large foramina for the exit of nerves. The whole ramus is very little curved, a condition specially remarked on by Lilljeborg in the Gräsö specimen.

The vertebra belongs to the lumbar region, though its exact position in the series cannot be determined. Its dimensions, as compared with the third and the sixth of the Gräsö whale, which are given by Lilljeborg, are as follows:

	Pentuan in.	Gräsö third in.	Gräsö sixth in.
Length of body	7½	8½	8¾
Height of body in front	7¾	7¾	8¼
Width do.	9	9	9¼
Distance between tips of transverse processes	36	35¼	37
Height to the top of the spinous process .	22	21	

* I have given Lilljeborg's figures in Swedish feet and inches, which are slightly smaller than ours, so that the bones of the two specimens are more nearly one size than appears at first sight. The Swedish inch is 0·9742 English inch.

It will be seen that it corresponds best with the sixth in general dimensions, allowing for the somewhat superior size of the Gräsö individual, but differs in the comparative shortness of the body, which is, in fact, the most notable point of difference between the two specimens.

The bones of the limb, which are preserved, agree very well in form with the figures given by Lilljeborg. Their dimensions are as follows:

	Pentuan	Gräsö
HUMERUS.		
Length	20½	21½
Breadth at middle	9	9½
RADIUS.		
Length (imperfect)	26½	29½
Breadth at upper end	6	6¼
Ditto at middle	6½	6¾
Ditto at lower end	8½	9 *

These bones have been much damaged, the radius especially having both extremities broken and worn.

Of the two bones of the hand, one is certainly a metacarpal, as it has an oblique articular surface at one angle of the proximal extremity, in addition to the principal terminal articulation. It is 6·3 in. long, and 4·4 in. wide at the proximal, and 5·1 in. at the distal end, and corresponds in form and size very closely to one figured by Lilljeborg. (No. 72, pl. vii.) The other bone, which appears to be a proximal phalanx, is 6·8 in. in length, 3·4 in. in breadth at the middle, and 4·9 in. at either extremity. It is

* Some of these dimensions are taken from Lilljeborg's figure, as they are not given in the text.

slightly larger than either of the four phalanges of the Gräsö whale which have been discovered, but these probably belong to a more distal part of the manus.

With so close a correspondence in dimensions, as well as general characters in such different parts of the skeleton (the discrepancies which exist being quite within the range of individual variation), we are obliged to assume the specific identity of the two specimens, although, of course, admitting the possibility that such an assumption might prove incorrect if a large number of bones were found. The two other recorded evidences of the existence of the species are less conclusive, inasmuch as each is based upon a single bone. The first is a cervical vertebra in a mutilated condition, wanting the neural arch, cast ashore in Babbicombe Bay, Devonshire, in 1861, and described and figured by Dr. Gray.* The second is a ramus of the lower jaw, preserved in the Museum at Rutger's College, New Brunswick, N.J., which Mr. Cope says "is of peculiar form, and closely resembles the figure given by Lilljeborg of that portion of this rare species."†

With regard to the systematic position of *Eschrichtius robustus* there can be no doubt but that it belongs to the family *Balænidæ*, or Whalebone-whales, though it cannot be placed in either of the three principal genera into which the group is divided; viz., *Balæna*,

---

* *Proceedings of the Zoological Society*, 1865, p. 40. *Catalogue of the Seals and Whales in the British Museum*, 1866, p. 133.

† *Proc. Acad. Nat. Science, Philadelphia*, 1868, p. 184.

Megaptera, and *Balænoptera*. It agrees with the two latter in having the vertebræ of the cervical region distinct from one another, and with the former in the rudimentary condition of the coronoid process of the lower jaw. Its relations have however been sufficiently discussed by Lilljeborg.

The interesting question remains whether this species still exists in our seas; if extinct, it must have become so at a comparatively recent period, certainly long after Cornwall was inhabited by man. The negative evidence of no specimen having been met with by naturalists in a living or recent state is hardly conclusive as to its non-existence, as our knowledge of this group of animals is lamentably deficient. We are acquainted with many species even of very large size only through isolated individuals, and the discovery of others new to science is by no means an infrequent or unlooked-for occurrence at the present time.

October 25th, 1872.

SOME REMARKS ON THE MINING DISTRICT OF YORKE'S PENINSULA, SOUTH AUSTRALIA.

By Samuel Higgs, Jun., F.G.S., F.G.S.C.,
Honorary Member of the Imperial Society of Arts and Sciences of Lyons, &c.; late Secretary to the Royal Geological Society of Cornwall; Superintendent of the Wallaroo and Doora Mines, &c.

I cannot but feel some degree of diffidence in presenting my observations on this important district to the Society, which will be the more readily conceived when I mention that I can find no record of this district ever having had the advantage of being visited by those great geological authorities, whose vaguest hints even often give a clue by which the lesser lights are enabled at times to approach, with some degree of confidence, such a subject as I shall now attempt.

Yorke's Peninsula is that tongue of land lying west of Port Adelaide, bounded on the east by Spencer's Gulf, and on the west by St. Vincent's Gulf. It is about 150 miles long, and varies in width from 25 to 50 miles. It is a country entirely destitute of fresh water, except in three or four places on the sea-shore, where wells have been sunk in the sand and some brackish water found, which, for want of better, cattle drink. The country from

the Hummock's range of hills, situated at the head of the peninsula, to the extreme south point, is nearly a dead level, undulating slightly in one or two places.

The only natural vegetation is a stunted mallee tree-scrub, the foliage of which is a dirty olive green. At certain seasons of the year its sombreness is relieved by the yellow blossom of the wattle-tree, with now and then a clump of native peach-trees, and an occasional bush of the native myrtle, with its diminutive white flower. The grass, known as spear-grass, after rains, grows rapidly, and for a month or two, in some places, affords fair feed for sheep; but a day or two of a South Australian sirocco (north wind) dries it entirely up, and the whole face of the country assumes the aspect of an arid wilderness.

Of animal life there is but little. Kangaroos, in some parts, herd in considerable numbers; and the wallaby, a small kind of kangaroo, is to be met with occasionally. That extraordinary burrowing animal, the wombat, may sometimes be seen of a fine moonlight night. There are several varieties of snakes and lizards, amongst them the iguana. Of birds, in the quiet parts, emus are sometimes met with; there are two or three varieties of hawks, of which the eagle hawk is the largest; the wattle bird—the shepherd's companion—a small variety of woodpecker; and several varieties of the parrot tribe, with magpies and ravens. These constitute just the whole of the wild denizens of the district.

The native population is small, numbering, it is thought, 160 all told; their numbers never exceeded,

perhaps, 350. The smallness of the tribe may be accounted for by the scarcity of water: the same reason may also account for the smallness of the native population in so many parts of Australia. I am not inclined to speak so disparagingly of the aborigines as the writers of some books are: I see pretty much of them, and find them to be shrewd observers, with a great fund of humour, and inimitable caricaturists.

The climate is a most trying one, and perhaps in no part of the world are the ranges of temperature so great. Often, during the daytime even, has my thermometer noted a difference of 40 degrees.

The hot winds and dust-storms hurled along from the dry parched plains of the north are at times almost unbearable; to work is altogether out of the question. During their continuance, all nature seems gasping, and birds soon succumb to their baneful influence.

The average rainfall is 10½ inches; the rainy months are June, July, and August.

Such is a general outline of the country, its inhabitants, and climate. And now I will pass on to its geological features.

Undoubtedly the surface rock or crust, and some of the overlying rocks, are of a very recent formation. To generalize, at first, I would state that as a rule the rock of the district is clay-slate, overlaid by a bed of unconformable limestone; in one or two places there is an overlying rock on the clay-slate, of a very recent tertiary formation, intensely hard, which makes

excellent building-stone; but even this recent formation has the same overlying bed of limestone.

On the east coast, on the shores of Spencer's Gulf, from Parrara to Black Point, one might almost say that a bed of this tertiary rock is to be seen gradually forming; for, the fossils, in the rock itself, are identical with the shells, crustacea, and other living organisations to be seen and found on the sea shore. Midway between these two points, in a sandstone formation, is a large deposit of phosphate of iron; at Black Point, the clay-slate protrudes, and here are to be seen several promising copper lodes, which, no doubt, when the metal commands a higher price, may be profitably worked. I am informed that the same recent formations of rock are to be found all the way down this coast, the clay-slate being occasionally exposed. Crossing the peninsula, about midway between the two Gulfs at Boors' Plains, is the bed of hard tertiary rock previously mentioned: it appears to be an older formation than the one just described. It is quarried for building purposes, but not to such an extent as to enable one to decide how it lies in connection with the clay-slate on either side of it. The bed would seem to run north and south, as I believe it is a continuation of the same formation to be seen some three miles further north, of which I shall presently have to speak. Reaching now across to the other coast, St. Vincent's Gulf, so far as I have been able to trace it, clay-slate appears to be the exposed rock, except about five miles north of the Port of Wallaroo. Here are several large courses or

dykes of quartz, running into the country in an east and west direction; and immediately north of these another kind of rock, gneiss, comes in. How far this rock extends I cannot yet ascertain; and besides, even to trace it now on paper, would take me beyond the boundaries of York's Peninsula.

The bed of unconformable limestone thus overlying the whole of the lands of the Peninsula varies in thickness from a mere crust to three and a half feet. In places it is intensely hard to break through, and in others it is very friable; as a rule, immediately under it is a bed of clay from three to twelve feet in thickness, but occasionally the rock is struck immediately under the limestone.

Having thus given a general outline of the geology of the district, I will now proceed to give some particulars of its mineral deposits. Indications of copper on the Peninsula were observed, in 1859, by a gentleman who then held the district as one of his outlying sheep-runs. Having picked up on the beach, near the site of the present smelting-works, some green-ore (muriate of copper), he became convinced that deposits of this mineral existed inland. It is not for me to dwell on the months of toil and hardship that gentleman went through before he had the satisfaction of proving that his surmises were correct; suffice it for me to remark that one happy day, in the year 1860, when exploring one of the dense mallee tree-scrubs, he came across the workings of a wombat; and there, thrown out and scattered over the *debris* of the hard limestone crust, so patiently dug through

by that extraordinary animal, was quite a burrow of green-ore. Pits were quickly put down, and very soon the back of the great Wallaroo lode was laid open, and its course traced up. This discovery was quickly followed by others of equal importance. Such then is the origin of the discovery of copper in this district, which so soon had to play an important part in the world's market for this particular metal. Without further preface, I will now proceed to give some description of the nature of the deposits, and will take, in the first place,

THE WALLAROO DISTRICT.

The main bearing of all the productive lodes is from 20 to 24 degrees south of east and north of west; and up to this time I have not seen, nor am I aware of, any copper in quantity being found in any lode much out of this bearing. The lodes warp in places considerably, and just at the angle of their so doing they are the most productive; if they continue in a straight line with smooth walls they soon become poor. The great Wallaroo lode, for the greater part, dips south, at an angle of 15 degrees; but in one place, where it has been very productive, it is almost vertical. The underlie here, if any, is slightly to the north. It is worthy of note, that where the lode is vertical, the quality of the ore is much richer (2½ per cent. produce, at least) than where it takes an underlie.

Milnes lode and North Mairs lode dip north, at an angle of about 12 degrees; the same remark, as to

the increased richness of the ore when the lodes take a downright course, applies also to these veins.

The Wallaroo main lode has been worked on for rather more than two miles in length, but not in all cases productively.

I mentioned, in generalizing the geology of the district, that its rock was clay-slate. Now, to particularize the mineral-bearing rock. It is now laid down as an established fact, that unless the clay-slate carries with it a considerable quantity of mica, or, indeed, unless it assumes almost the character of a mica schist, the lodes will not carry copper in payable quantities: hence one of the reasons of the occasional non-productiveness of the Wallaroo lodes, and the cause of so many disappointments. Another cause of disturbance in the lodes is the numerous slides and faults. The slides are most irregular, but all the principal ones have a tendency to throw the mineral deposits westward; this is plainly shown now in our deepest workings—120 fathoms—where the main shoot of ore is carried away bodily by a slide.

Here, again, is another matter, I think, worthy of note. At the point where the lodes are cut off by the slides, they are more productive; and the same thing is observable when they are picked up again on the other side of the slides.

The lodes are not rich in either metallic or earthy minerals;—copper, hæmatitic iron, tourmaline, schorl, in their respective forms, and manganese—(in this latter ore, from the back of more than one lode, I have found traces of gold and silver)—quartz not well

crystallized, two or three varieties of calcite, and occasionally molybdenite near the change of the copper ore from muriate to the sulphide, constitute just the whole; barytes near the clay is sometimes met with. In one or two places a small cross-vein has led to small deposits of galena, not rich in silver.

About three miles north of Boors' Plains, close to where there is evidently a continuation of the tertiary formation I have alluded to, considerable quantities of lead have been raised, and the whole of the surface is covered over with nodules of hæmatitic iron. The mine has been abandoned for some years, so that I am not in a position to give further particulars about it.

I am not prepared, in this paper, to say anything about the cross-courses or their influences on the lodes; in fact, they have not been sufficiently proved to warrant my hazarding any remarks about them.

All the lodes in this district have been found by surface indications, either from green-ore being thrown out by the wombats, or worked up by some of the burrowing insects.

This green-ore is almost invariably a muriate; sometimes the copper is found in the form of a grey sulphide adhering to the limestone crust, oftentimes coated over with a layer of lime. In the former case, the lode can easily be traced up and the ore easily taken away, for the ground is generally soft; the green-ore lasts down as a rule about 13 fathoms, when it changes to a black oxide, and very soon after —say another three fathoms—to the usual sulphide

of copper, more or less mixed up with iron pyrites. If the lode is very productive, the iron pyrites gives way entirely to its more valuable associate.

There is one thing to note respecting this iron pyrites; it is generally on the productive lodes found in the hanging wall, so that, when dressing the ore, the iron pyrites is easily picked out.

Where the surface ore takes the form of a grey sulphide, it soon changes to a red oxide, not unfrequently intermixed with malleable copper, and which soon changes to the sulphide of copper, perhaps at an average depth of 12 fathoms. The surface deposit from a lode of this sort is much richer than when the back forms a muriate. In the one case the percentage of ore may average 20 per cent.; in the other, 10 per cent. would be considered good; but this difference of quality as regards surface-ore does not hold good with the sulphides under: the quality under both would be about the same.

The size of the lodes varies considerably, from 20 feet to one foot wide.

The great shoot of ore on the Wallaroo Mines at the 40 fathom level was 16 feet wide of solid ore, of 12 per cent. produce.

The water in all the mines is intensely salt. Fortunately for pitwork, there is no free acid with it, hence little inconvenience is felt in this respect; but as it is the only water we have to condense with, the boilers corrode very quickly, and have to be cleaned every six or eight weeks.

The quantity of water in the district cannot be

considered excessive, and it would appear as if there were two main water-courses—one about 17 fathoms in depth, and the other from 45 to 70 fathoms. Below this, there is only water enough for the usual requirements of the mine.

It is estimated that over 250,000 tons of 12 per cent. ore have been returned from this district since the first sales in 1861 to the present time.

THE WALLAROO MINES,
2nd January, 1872.

ENQUIRY INTO THE NATURE OF THE FORCES THAT HAVE ACTED ON THE FORMATION AND ELEVATION OF THE LAND'S END GRANITE.

By the late Miss Elizabeth T. Carne.

This district possesses special advantages for such an enquiry. The other granite masses of Devon and Cornwall have been elevated in the midst of other formations, and their central situation and covered flanks give little opportunity of gathering together the facts necessary to support any enquiry into the nature of the forces that have acted on them. Our Western granite, on the contrary, is largely surrounded by the sea, and possesses a variety in its internal and external structure, which may perhaps supply us with facts on which to base some fair and reasonable deductions.

I. Let us notice the internal structure of Cornwall. If we look at a geological map of Cornwall, we shall see that the various granite bosses (including Dartmoor) lie on lines which approximate to E.N.E. and W.S.W. So, too, the large majority of the mineral veins and elvan courses run a little N. of E. and S. of W.; the greenstone bands also; though I question if these do not need further investigation. With

occasional exceptions, all this holds good throughout Cornwall.

II. There is the external configuration of the whole surface; and on this head we have to distinguish between original structure and structure which has been superinduced. The very first question is, Are our valleys valleys of erosion or otherwise? If of erosion, the whole superficial structure has been superinduced, and in no degree bespeaks any peculiarity of structure in the original formation. But if not of erosion, any parallelism in the system of our valleys points to some law which has probably influenced the original structure. It is the fashion to consider all valleys as valleys of erosion, unless they can be proved to be otherwise; but certainly he must be much blinded by a theory who can see valleys of erosion in West Cornwall granite. In the first place, the narrowness of the land from sea to sea supplies no water sufficient to cut such valleys. If it be said that the land might have been ten times as broad in past ages, that does not touch the point in question, for we have manifestly the central portion remaining, the backbone of the watershed. If the land had stretched from Mount's Bay to France, it would not alter the fact that it is only five miles from Mount's Bay to the granite ridge between St. Ives and St. Just, which is the head of our streams of water. Five-mile streams could not cut such wide valleys in any lapse of ages. Small streams would cut a little channel sufficient for their own small course, and they would sweep away all loose stones and gravel

long before they would cut through tough granite, leaving us bare rocky water-channels instead of our wide and rounded hills and valleys. There is no doubt that erosion has acted on our valleys, it acts on everything; but, inasmuch as it is utterly insufficient to cut out our valleys, they must be referred to some antecedent cause. Mr. Whitley, long ago, pointed out that the Cornish valleys form parallel lines running from N.W. to S.E., and having often sharp bends at right angles to this course; also that N.W. and S.E. is the line of the predominant joints of the rocks; and he suggested that a common law ran through both series of phenomena. This, then, is the first thing that strikes us as probably betokening original structure, a series of predominant joints and valleys running from N.W. to S.E., with cross joints and cross valleys at right angles to the first.

III. There is the structure of the granite itself, and of this there are three forms well marked in their extreme types, though continually passing into each other.

1. That in which perpendicular joints predominate, and which forms cliffs much resembling basalt in aspect, as may be seen in many places between the Land's End and Tol-Pedn-Penwith.

2. That in which horizontal joints predominate, and which forms Tors, pre-eminently characteristic of Dartmoor, but which may also be seen at Carnbrea, and on the range of granite hills between Zennor and St. Ives.

3. That which belongs to our best and hardest

granite, where both sets of joints are less prevalent, and which therefore forms deep courses in our quarries, and huge masses on our carns and cliffs. Considering that some kind of force has produced the most prevalent joints, we may regard this third form of granite as simply due to the absence of such forces, and therefore limit our enquiry to the two other forms of granite, that distinguished by tabular slabs, and that resembling basaltic pillars. Here analogy may help us. Anyone who has been in a basaltic country like Madeira, or who has seen or read an accurate account of modern lava, is well aware that both basalt and lava may be seen in precisely these two extreme forms. Where surface movement or surface influences have predominated, the lava and basalt take a horizontally laminated form, the air-vessels are elongated in the direction of the motion, the texture is vesicular and scoriaceous through rapid cooling, and the harder portions lie in narrow slabs horizontally with the mass. But in lower beds, or in lower parts of the same bed, the basalt, and less frequently the lava, takes the upright pillar-like form with which we are all familiar in pictures of Staffa and the Giant's Causeway, and which is expressed by, I believe, an invariable formula, "Main joints at right angles to the surface."

My inference is, not that granite, and basalt, and lava had the same origin (which would be a rash conclusion), but that they have come under the influence of the same forces. I regard the predominance of tabular forms (the result of predominant

horizontal joints) as essentially a surface structure—the structure which bears a presumption on its face, that, of the whole mass to which it belongs, it has been most exposed to external influences. Those influences may comprehend lateral movement, or rapid cooling, or lessened pressure, or altered chemical conditions. We must go elsewhere for proofs of any or all of these; but I think we may fairly venture to say that the structure itself *does* bespeak more of the influence of external agencies, while, on the other hand, the predominance of pillar-like forms (the result of predominant perpendicular joints) bespeaks more of agencies inherent in the nature of the rock itself.

All quarrymen will bear witness that it is rare to find granite at the top of a quarry that will come out in fine square blocks. We can see for ourselves on entering a quarry, by the cracks on the sides, how apt the granite is to lie in shallow layers near the top. Whatever has been the cause, it does seem to be a surface structure; and I use the term "surface" in the widest sense, meaning that part of the mass which has been most exposed to external disturbing influence. I must remark that this appears to me a rule of some practical importance to quarrymen. I noticed at Zennor how often the hills were scarred by attempts at quarrying, but the granite was generally of a coarse description. According to my views, the chances were ten to one that it would be so, when right over my head on the hillside lay the great tabular carns, which showed that the whole

hill was surface granite. On the other hand, do not many of us remember the beautiful upright masses of granite on the east side of Lamorna Cave, which Mr. Freeman has blown to pieces? They were the result of perpendicular joints; that is, of more undisturbed crystallizing forces in the granite; and the chances were that the rock around them would be hard and fine-grained. Some years ago I was at Chagford surrounded by tabular tors, but the granite is poor and the softest I ever saw; but at Hey Tor they have good granite quarries, and I saw there what I never saw elsewhere—the abrupt junction of the two sorts. There is, or at least there was, a great mass there like a gigantic mushroom: the overhanging part was in great quadrangular blocks, and of very coarse texture; the under part was in perpendicular blocks, and of beautiful fine-grained granite, with the line between them as sharp as that between the pillars and the laminated beds of a mass of basalt. But I must admit that this rule will not bear universal application; for the granite at Sheffield quarry, in Paul, is said to be the best in the neighbourhood, though tabular slabs are to be found on the hill westward of it and at Castallack Carn. And I think it possible this rule may not apply at all in other localities, and for this reason: that when the granite has risen in inland districts under a heavy mass of slate, the great pressure to which it is subjected may produce hard, fine-grained granite even in close proximity to the tabular carns, which bespeak disturbing external agencies. I think

we must look to pressure as the probable agent which interferes with the different forces that produce both horizontal and perpendicular joints. Where the granite has been so compressed that it can yield neither to external influences nor to internal crystallization, there we shall probably find it the hardest and most free from joints. The good quality of the Sheffield and Lamorna granite supplies a suggestion that that district has been subjected to unusual pressure.

IV. There is the composition of the granite.

The mixture of quartz, felspar, and mica, to which we give that name, is subject to great variety, of which hand specimens may be procured in every part of the district; but looking on our rocks in the great mass, I think we can only distinguish three principal kinds of granite. 1st. Our common quarry stone, in which large crystals of felspar occur in a mass of mixed felspar, quartz, and mica, and which prevails over the whole district, if we except St. Michael's Mount. 2nd. Ludgvan granite, which is found in small masses in several parts of that parish —a rock remarkable for its whiteness and abundant glistening mica. Of this sort are the granite pebbles, found on the eastern end of Marazion sands, and also, I think, the chief mass of St. Michael's Mount; but I say this doubtfully, not being able to chip even the stained sea rocks of that close preserve of granite. 3rd. Our so-called "moorstone"—a very small-grained mixture of mica, quartz, and felspar, which is found lying loose on the moors around Castle-an-

dinas, Choon Castle, Bosphrennis Hill, &c., and also (and this deserves notice) on the tops of some of our highest hills, Trecrobyn and Pertinney, as also on Carnbrea, in the Redruth district. This stone differs from our common granite, not only in composition, but in structure, being found in flat, angular, shapely pieces, needing little squaring with the hammer to fit it for building purposes. It forms our dryest, toughest, best building stone.

V. There is the dip of the rocks. The old theory was, that the elevation of the granite had simply thrown off the slate on every side of it; and in corroboration of this, we were told that the dip of the beds between Newlyn and Mousehole was S.E., as we might expect it to be, and at the Gurnard's Head N.W., as we might expect it to be. Now, even as much as this needs qualification. If it were a little S. of E. at Mousehole, it should be due E. at Newlyn and the western rocks of Mount's Bay; but it is not, it is fully as much S.E. at the Wherry Rocks and round the Battery Rocks, and at Chyandour Rocks, as at Mousehole. Also, on this theory, the patch of slate at Rosemodris should dip due S., and that, too, dips S.E. Also, all the rocks around Lelant should dip E., and they, too, dip S.E. I grant indeed that the Gurnard's Head should dip to the N.W., but unluckily its beds dip to the N.E., and so on the great scale do most of the cliffs around Zennor—at least, a little E. of N.—when any dip can be plainly discerned. As far as my observation goes, I do not hesitate to say, that all around our

coast there is a predominant dip towards the E., that from Carbus-water to the Logan Rock the dip is S. of E., whilst all around the Zennor coast it is N. of E., or rather, perhaps, E. of N. I do not think this can be explained by the mere elevation of the granite. Then there is another objection to the elevatory theory of dip. This dip towards the E. southward on one side, northward on the other, *is shared by the granite itself*—shared to the full. S.E. is the prevalent dip of our southern granite: N.E. is the dip of the granite at Wicca Pool. This shows beyond all question that the force which has produced the prevalent dip of our rocks has acted equally upon both rocks, and is not the exclusive result of the elevation of the granite.

Here, then, are the materials with which we have to deal:

1st. The internal structure of the country, common to the rest of Cornwall.

2nd. The external configuration of the country, common to the rest of Cornwall.

3rd. The structure of our granite.

4th. The composition of our granite.

5th. The dip of both granite and slate.

The next step is to go rapidly through these various points in their application to the Land's End district.

1st, as to internal structure. If we compare the form of our granite with other granite bosses, we shall perceive that it is of a very peculiar form. It first forms a long line from St. Ives to St. Just, and

is then bent southward and eastward to the Logan Rock and Paul, and finally bent again in a projecting piece westward to the Land's End; in short, it is something like a reverse form of the letter Z. If we look at the elvans, they run approximately on E.N.E. and W.S.W. lines all through the country till they reach Sancreet. It is difficult to trace elvans through granite, but we are told that that which occurs at Bosava runs N. and S., also that at Mayon, near the Land's End. If we look at the bands of greenstone (though, I repeat, I think these so much need further investigation as to be worth little in the argument), we find them running through the country approximately on E.N.E. and W.S.W. lines until we come to Paul Hill, where the great greenstone band is bent round N. and S. If we look at the mineral veins, we find them chiefly (with one or two local exceptions) running through the county approximately on E.N.E. and W.S.W. lines till they come to Morvah; then a blank space ensues, and immediately follow the whole of the St. Just veins, running chiefly on N.W. and S.E. lines. In the mass of granite bent to the south no veins of any consequence have been discovered, while at the same time the valleys of Lamorna and Sancreet contain the largest deposits of stream-tin in the neighbourhood. The one exception seems to be the Garth Mine above Buryas Bridge, where the veins run E. and W., resembling the rest of the county, and *not* the neighbouring parish of St. Just. We must notice also that the valley of Nancherrow forms a line of

disturbance in the dip of the tin veins, those to the N. of it dipping S., while those to the S. dip N.

2nd. If we look at the external configuration of the district, we shall see a series of hills and valleys and prevalent joints running on N.W. and S.E. lines, in this agreeing with the rest of the county. We may note especially the valleys of Nancledrea, New Mill, and Madron or Ding Dong, and in the southern part of the district, Lamorna and Penberth. But in Sancreet we find a district of disturbance, and the valley line which runs from Kelynack to Drift and Newlyn is almost W. and E.

3rd. If we look at the structure of the granite, we see a great line of hills more or less marked by tabular—or, as I deem it, surface—structure, running from St. Ives to Pendeen, and then bent to the south at Carn Bosavern, south of St. Just. After that it almost disappears; possibly it may be found on Pertinney and the Sancreet hills, but I have not been able to hunt for it; and it exists in a feeble form at Castallack Carn, and on a hill west of Sheffield Quarry, and on Paul Hill, and in a quarry at Rose-an-beagle. But its almost total disappearance is a marked characteristic of the southern granite, just as the presence of basalt-like granite is characteristic of our western cliffs between Tol Pedn Penwith and the Land's End.

Our object now is to enquire what forces and what circumstances will so far harmonize with and explain this variety of facts as to supply us with some reasonable and probable conjectures as to the formation

and elevation of the West Cornwall granite. I have no intention to enlarge upon the various theories of the origin of granite, but I must just touch on the three principal ones. The first is the theory of eruption; that granite as a molten fiery mass was pushed from below into contact with slate deposited by water from above, as lava might be pushed into contact with later stratified beds. The insuperable objection to this is the uniformity of the circumstances that attend the junction of granite and slate —the intimate commingling of their elements, even while the line of division is sharp and clear—felspar saturating the killas, and the dark substance of the killas creeping into the granite; but still more than this, the invariable presence of a band of purple killas round every mass of Cornish granite forbids us to attribute their junction to the hap-hazard influences of eruption. It is a law, not a chance, which has connected the two.

2nd. There is the theory of metamorphosis, sometimes so broadly stated as to present no other idea than that all slate is decomposed granite, and all granite recomposed slate, a theory equivalent to the assertion, that of two successive forms neither was formed first. More moderately expressed, this theory asserts, that though granite is metamorphosed and reconstructed slate, slate must be assumed to be the disintegrated product of some rock analogous to granite that has ceased to exist. But why should we call up needless difficulties in the shape of pre-existent non-existent rocks? If we can conceive of

rocks formed prior to their disintegration, we have that conception to begin with, and must not beg the question of their being metamorphosed, short of proofs of metamorphosis. I dare not say, having only local knowledge to support me, that granite is not reconstructed killas; but I have never been able to detect the slightest proof of it, whilst even in West Cornwall there is abundant proof of the identity of killas and greenstone. Even in the face of written testimony, I venture to assert that the metamorphism of granite rests rather on the credit of great names than on the strength of sound inductions.

Lastly, there is the contemporaneous theory, which has met with deserved objection by being put forward in a literal rather than in a large sense. Considering how little we can know of the formation of rocks which takes place deep under the earth or the sea, it would be folly to say that the formation of granite and slate was actually simultaneous. And I think no one can see an extensive junction of granite and slate, as in that splendid instance for a quarter of a mile round Wicca Pool, without admitting that the slate was certainly in a *less plastic* state than the granite, for the fragments of slate are sharp and angular amidst the surrounding coils of granite. Either it had been formed a little earlier, or it had *set* and hardened sooner. All that should be understood in the term "contemporaneous" should be the close relation of the circumstances that have influenced the formation of both rocks, and of the forces that have acted on them. The close attendance of the

killas on the granite, the commingling of their separate elements, and the parallelism of the veins, elvans, &c. that run through both, seem to attest the subjection of one to the forces that acted on the other. Hence, amidst the slow operations of nature, we think of them as belonging to the same era in formation, though one might have been the first page and another the second.

Now let us recall the internal structure of the whole of Cornwall, and part of Devonshire.

Masses of granite in various parts on N.E. and S.W. lines, with bands of greenstone (though I think these need investigation), elvans, and mineral veins on the same lines. Is there any theory to account for this? Mr. Hopkins has attributed them all to universal magnetic forces acting on N. and S. lines. But it is rather a wide interpretation to find the proof of meridional, that is N. and S. forces in lines that lie N.E. and S.W., nay, rather nearer E. and W. Still we know that the magnetic pole was once east of the true north, and we might suppose that Cornwall assumed its internal structure in that far-distant period. All the more, if, as has been said, these N.E. and S W. lines are of common occurrence all over the world. It is such a pretty theory. I have turned it round and round, trying to fit it into the facts; but, unhappily, Mr. Hopkins's whole theory supposes that the forces come from the S. to go to the N., while the facts say that they come from the N.E. and pass to the S.W. I have no theory to offer. If the forces that influence structure rose rapidly from the centre

to the circumference of the earth, they would acquire a bend from E. to W. by the increased rapidity of surface rotation, as currents in the atmosphere do in the phenomena of the trade-winds. But we have no knowledge of the precise action of the earth's internal forces. I prefer, therefore, without any attempt at theory, to take the existence of N.E. and S.W. forces for granted, and to regard them as structural forces, that is to say, not accidental disturbances, such as volcanic eruptions would be, but as forces that have the nature of a law (though at present we are ignorant of its precise nature), such as magnetism, heat, and chemical affinity. I regard these forces as having acted on what is now Cornwall while it lay deep beneath earth or sea, while the granite or slate were forming, or before they had lost their first plastic elasticity.

Among these forces I seem to recognise one resembling that which is still apparent in earthquakes, a great undulatory movement, to which I think we must attribute the subsequent elevation of the granite and slate, and also certain effects which took place even before it rose or while it was rising. What else but a great undulatory movement could produce a whole system of hills and valleys and predominant joints—and may we not also include cross-courses?—all at right angles to its course, that is on N.W. and S.E. lines? What else could produce such wonderfully uniform effects—one great wave following another, producing pressure on the same lines of resistance, and tension, and fracture on the same lines of weak-

ness, as resistance was overcome? Undulation acting on the granite while it was *settling* would produce swelling hills and valleys; undulation acting on the granite while it was *shrinking* would produce predominant N.W. and S.E. cracks or joints. I used to think these might be due to some incipient law of crystallization, but I do not see how this could act alike on such different substances as greenstone, granite, and slate, and they all share in the predominant N.W. and S.E. joints. I do not see any other interpretation that can possibly meet all the facts. A central point of elevation would not do it, for we should have had a system of radiating valleys and joints, and of radiating dip in the rocks all round a centre; and a line of elevation would not do it, when the valleys were manifestly too wide to have been produced by erosion. On all these grounds, I venture to assume that the force which elevated the granite was an undulatory force.

And now I must recall what was said of the surface structure of granite; namely, its tendency to form tabular slabs from the prevalence of horizontal joints. While it was rising, or even before it was rising, if lessened pressure allowed it any kind of expansion, an undulatory movement would tend to roll or stretch it, probably causing it to assume this structure, until the whole surface hardened and set in a series of flat shallow slabs, or onion-like curves, the fragments of which we still see on the tops of quarries and in tabular carns. How come they to be such fragments? Let us think. An undulatory

force coming from the N.E. would tend to make perpendicular joints at right angles to it, but it would act against the horizontal joints, or tabular slabs, straining and shattering them in every direction. More than this, the lines of shrinkage would be on N.W. and S.E. lines, and as the granite in drying gaped and parted, down would go the horizontal slabs, smashing themselves in pieces. That is exactly what we see—lines of carns on our sea cliffs, with intervals of soil and angular stones between them, and loose stones all over our moors, deeply imbedded in granite gravel. The loose stones are (as it were) the knots in the wood, the hardest bits of the tabular slabs; the gravel is the decomposed representative of the soft, shattered surface beds.

And now let us see how this undulatory force would act on the west of Cornwall. Most of the other masses of Cornish granite have a circular form. It is the form of equilibrium, speaking of balanced forces around it; but the West Cornwall granite is twisted out of all shape. Plainly the forces around it were not equally balanced. This is what I conjecture to have happened from its harmony with existing facts. The undulatory movement coming from the N.E. struck the N.E. corner between St. Ives and Hayle (and this I think must have happened very early, before the internal structure of the whole of Cornwall was fully developed; for which I will give my reason hereafter); but the granite was perhaps a little hardened at the sides

nearest the slate, and the slate, perhaps, with its crystalline greenstone bands, was a little harder still, and the granite was pinned down, partly on the N., but still more on the S., and instead of rising in a circular mass, it stretched out in a long line from St. Ives to St. Just; then it was jammed again by another bit of slate and greenstone, and was bent round to the S., where, perhaps, it met the remainder of the granite struggling upwards under the Mount's Bay beds of slate.

Now, what would happen if this took place? I have assumed that though the granite between St. Ives and St. Just was confined in its course, it was not greatly disturbed, not more disturbed than the granite in the inland parts of Cornwall. It would, therefore, retain something of its external tabular structure, and wholly its internal structure of N.E. and S.W. mineral veins; but, as it drew near St. Just, it would be fearfully disturbed. The granite would be turned round in St. Just parish as on an elbow, producing enormous strain and fracture on N.W. and S.E. lines, and the surface beds would be shattered in pieces, being exposed to a double strain—first by the undulations against the horizontal joints, then by the wrench round to the S.E., at right angles to their previous direction. And now what do we see in St. Just? A disturbance in the N.W. and S.E. lie of the valleys, a cessation of the N.E. and S.W. mineral veins, and a whole network on new lines in St. Just, on those very N.W. and S.E. lines which would have been produced by the tension and frac-

ture of the granite, had the mass of it been bent to the south. Also we see the entire disappearance of the surface tabular granite south of Pertinney. The pressure on that twisted portion has been enormous, and the wreck has been immense; therefore it is that in that southern district we have our best granite, the result of greater pressure, and our best and deepest granite soil, the result of greater wreck. But how about the disappearance of tin lodes and the existence of tin streams in that southern district? Is it so certain that there are no tin lodes? If, indeed, none are ever discovered, I should assume that the twist in the West Cornwall granite began very early, and that it interfered with the structural development of E. and W. veins which was taking place in less disturbed circumstances in the rest of Cornwall. As to tin streams, my belief has long been that stream-tin—so fine in its quality, so peculiar in its structure—owes its origin to influences different from those that have formed tin lodes, and is most probably a surface formation, one of the fragmentary remains of the vanished surface beds of the granite. But this should form a separate subject in itself. I only remark here, that it is entirely in harmony with this view, that in the district where we find the surface beds most shattered, and destroyed, and washed away, we should find the most abundant deposit of stream-tin; for this has been nature's great stamping-mill, and our tin streams are its washings. One result of this view would be that the St. Just lodes are more recent than the chief part of the

Cornish lodes; *i.e.* those on N.E. and S.W. lines. Yes, we should be obliged to refer them to a later period of quiet which followed the disturbing twist in the granite.

I feel justified and encouraged in this opinion by the fact that Mr. Carne, in his paper "On Veins," has previously come to this conclusion on entirely separate grounds.

There is one little bit of granite still unaccounted for; namely, that bit of the Land's End district west of a line drawn from Whitsand Bay to the Logan Rock. I believe this to be the latest of the whole, and that it was rolled or poured out as a separate bed from under the south-eastern part after it was hardened, and still retains the structure common to beds of basalt.

(Read at Annual Meeting, October 30th, 1874, by the Curator.)

REMARKS ON

THE LODE AT WHEAL MARY ANN,

MENHENIOT.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

Some weeks ago I was underground at Wheal Mary Ann, and I there observed certain peculiarities in the lode which, I think, are worthy of being recorded, especially as the mine is on the point of being abandoned, and further observation will be impossible —at all events, for some years.

It is true that the peculiarities of Wheal Mary Ann have not escaped the observant eye of Mr. Henwood, who has described the lode in the *Transactions* of this Society,* and also in the *Journal of the Royal Institution of Cornwall.*† Mr. Giles has also written upon the same subject in our *Transactions*,‡ and so has Mr. Salmon in the *Mining and Smelting Magazine.*§ However, in no published account have I been able to find any cross-section showing the structure of the lode, and as I can supply this omission, I have no hesitation in going over what may appear to some persons an old story.

The lode runs a few degrees east of true north, and dips east at an angle of 60° to 80°. The flatter parts

* Vol. viii. p. 704.
† 1851, p. 42.
‡ Vol. vii. p. 202.
§ Vol. ii. 1862, p. 218.

of the lode are generally poor, and filled with fragments of killas, or clay-slate, which constitutes the surrounding rock or "country." I need not dwell, however, on this point, as it is a common occurrence, and can easily be explained mechanically. I proceed at once to the main subject of my paper, in which I shall first describe the appearances shown underground at Wheal Mary Ann, and then point out what are the conclusions that may be drawn as to the formation of the lode. I greatly regret that I could only make observations over a very small extent of the lode. I simply saw one end at the 250 fathoms level, and one set of stopes, the only workings going on; but the facts observed were so clear, that I feel almost sure that my opinions would be confirmed, rather than shaken, by additional evidence.

DIAGRAM No. 1.

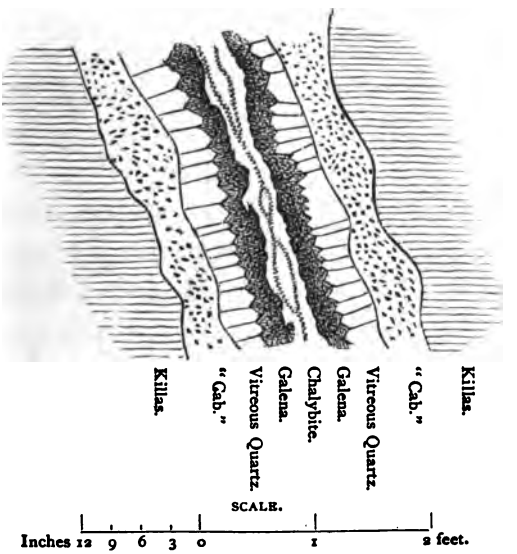
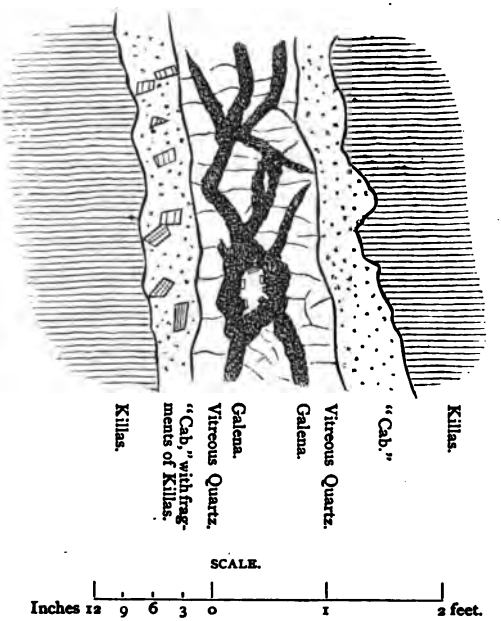


Diagram No. 1 shows a characteristic section of the lode as seen in the 250 fathom level. We have, first of all, the two walls of killas; then, proceeding inwards from each wall, the *cab*, a sort of chalcedony; next, ordinary vitreous crystallized quartz; next, galena; and finally chalybite, or spathose iron. The *cab* varies from 2 inches to 2 feet wide, and the lode proper is from 0 to 3 feet wide. If this were the only section seen, we might conclude that an open fissure had simply been gradually filled up by the successive deposition of the various minerals which we now find there; but the examination of other sections shows that, though simple, the process of filling up experienced breaks and interruptions.

DIAGRAM No. 2.



Another diagram (No. 2) shows a section somewhat like No. 1, save that the *cab* on the footwall contains angular fragments of killas.

DIAGRAM No. 3.

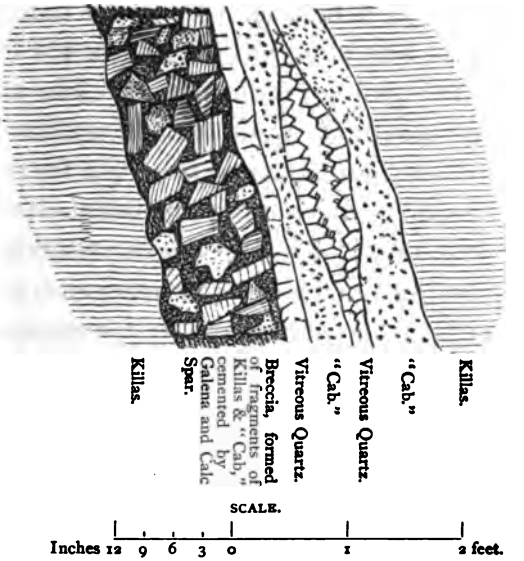


Diagram 3, taken from the lode close to No. 1, is very different in appearance. On the eastern or hanging wall, we have the *cab* traversed by a vein of vitreous quartz, which crystallizes out in a *vugh;* then a band of vitreous quartz; and finally, on the footwall, a complete breccia of fragments of killas and *cab*, cemented together by galena and calc spar.

From the examination of these sections, I deduce the following history of the formation of the Wheal Mary Ann lode:

Firstly, formation of a fissure, probably accompanied by a shifting of the strata. A succession of

open spaces were left, and some parts were more or less filled up by fragments that fell from the walls.

Secondly, deposition of the *cab*, which more or less filled up the fissure and cemented any fragments of the walls into a breccia. As would naturally be supposed, this breccia occurs chiefly on the footwall.

Thirdly, re-opening of the fissure. The new line of fracture sometimes went in the middle of the filling up of *cab*, sometimes cut across it, and then followed one of the walls of the original fissure; pieces of the walls, and of the previously-formed *cab* lode fell in, and then quartz, galena, chalybite, and calc spar were deposited successively in the open spaces.

The history of the formation of the Wheal Mary Ann lode is therefore not devoid of interest. Had I been able to see more sections, I have no doubt other peculiarities might have been observed, though I expect they would have been essentially similar to those I have described.

I can supplement this account of the Mary Ann lode by pointing out the order of deposition of some of the minerals that is shown by specimens given to me at the mine.

A large specimen shows:

1. Fluor spar.
2. Quartz.
3. Galena.
4. Quartz.
5. Chalybite.
6. Fluor spar.
7. Iron pyrites.
8. Calc spar.

Another specimen gives the following series:

1. Fluor spar.
2. Galena.
3. Fluor spar.
4. Quartz.
5. Chalybite.

Another:

1. Fluor spar.	2. Quartz.
3. Calc spar.	

A fourth gives us the series:

1. Fluor spar.	3. Galena.
2. Chalcedony.	4. Fluor spar.

There have, therefore, been at least two periods of formation of fluor spar; the lead ore was deposited at an intermediate period, and the last minerals have been quartz, chalybite, and calc spar.

I have given these instances of the successive deposition of various minerals, as this subject is too frequently passed over. It is, however, of importance in the study of lodes, because it enables us to compare lodes, not only when situated in different parts of the same district, but also when situated in different countries. For instance, what can be more striking than the fact that the one definite order of deposition of the minerals in the tin lodes of Saxony should hold good, in many cases, in the tin lodes of Cornwall? In conclusion, let me add that this branch of geological investigations has been too much neglected in England, and that there is, consequently, a wide field of labour for the geologists and mineralogists of this county.

30th October, 1874.

NOTICE OF

A VUGH IN ST. IVES CONSOLS MINES.

By Captain John Gilbert.

(Communicated through T. S. Bolitho, Esq., 30th October, 1874.)

About five months ago we discovered in the St. Ives Consols Mines a very large Vugh, the description of which I thought might probably be found interesting. We met with the vugh in driving the 167 fathom level under the adit, or about 190 fathoms from the surface, on Daniel's lode, which is the most southerly lode now working on in the mine. Our attention was first attracted by a small stream of water spirting out strongly from what we considered to be the south wall of the lode. We determined at once to drive in the direction that the water was coming from, with the expectation of meeting with a part of the lode that we had never before seen. We had scarcely driven two feet south before we met with some large horizontal fissures that led to the vugh, and drained from it in a few minutes a very large quantity of water, that afterwards I computed to be by measurement at least six thousand gallons. The mouth of the vugh was nearly cylindrical, and about 2½ feet in diameter, and was covered with crystals of quartz, or "spar,"

varying from two or three up to six inches in length. I crawled through these teeth for over three fathoms, and for this distance there was scarcely any variation in the size of the vugh; but this appeared to be only a passage leading into a large chamber which I measured to be 15 feet long, 12 feet wide, and 10 feet high, the back and sides of which were covered with crystals similar in size to those found in the opening. There were no crystals, and very little spar, in the bottom of this place; but a deposit, for the 12 feet wide, of low-produce tin capel, which we find will assay for tin about 1½ per cent. In blasting the sides and roof we found an incrustation of quartz, averaging a foot in thickness, spotted here and there with a little bright yellow copper ore. Inside this crust there was the solid granite rock, with not a trace of any lode or lode matter whatever. The vugh still continued for another six fathoms, but of smaller dimensions, and with very much the appearance of a small underground level that had been for a long time abandoned. In these six fathoms there were only a few crystals of spar to be seen, and the roof and sides were very much shattered, as if the rock had been dislodged by the influence of either air or water. In searching these sides we found some specimens of carbonate of lime, with traces of dolomite, and some good stones of blistered copper ore. We have now opened altogether on the vugh about 12 fathoms; at the end of this distance it is divided into three parts, two of which are bearing, one east and the other west, and rising eastward at an angle of 45 degrees; the other

part is running a little to the east of south, and this we consider to be the leading part, as there is still coming from it a small quantity of water. This vugh has been unlike any other vugh ever found in the mine, inasmuch as the other vughs always continued in just the same direction as the bearing of the lode in which they were formed; but this separated from the lode at almost a right angle, the bearing of Daniel's lode being 14 degrees south of east, and the bearing of the vugh for the 12 fathoms about 5 degrees west of south.

St. Ives Consols Mine,
29th September, 1874.

NOTICE ON MOUNT BISCHOFF, TASMANIA.

By Mr. William Wellington.

(Communicated by T. S. Bolitho, Esq., 30th October, 1874.)

The Mount Bischoff Tin Mines are situated about 100 miles from Launceston, and 52 miles from Emu Bay, an open roadstead on the N.W. coast of Tasmania.

The rock formation from Launceston to Emu Bay is principally basaltic. Twenty miles from Emu Bay, at the Hampshire hills, there is a little granite, where I discovered a very small quantity of stream-tin in the bed of a river with very little wash. The rock, from here to the Surrey hills on to Mount Bischoff, is all basaltic. The rivers were running very rapid in the rock.

Mount Bischoff rises on a plain about 1,000 feet high, having no connection with any other mountain, no other being nearer than seven miles.

The Mount Bischoff is clay-slate, surrounded on every side by basalt, with the river Waratah almost making a circle at the foot of it.

The top of Mount Bischoff is a vast amphitheatre, and in my opinion is the crater of an extinct volcano. The tin has been thrown up at three different periods. The first deposit, of about 6 feet, is composed of small detached pieces of porphyry, granite, and tin dissemi-

nated through it. The next eruption is more granite, in the shape of large boulders, and not so much tin. The last eruption appears to have been the most violent, sending up large masses of granite and the greatest quantity of tin—large lumps of tin on the surface sometimes several cwts. in weight; also a great quantity of tin, very much like smithy ashes from a stack, which is very difficult to save.

From the bottom of the cone to the top is about 200 yards, in the shape of a basin, with the tin deposit lying within the cone. On the top of the cone the mountain is very steep, in some places almost perpendicular. There is no course of tin outside of the cone, only fine smutty tin of no value; nearly all the tin is within the crater.

The extent of tin ground within I should think about 150 acres, with about an average of 15 feet depth of tin deposit. The bottom of the deposit is clay-slate. The tin appears to be of a very inferior quality, or low percentage. There is a total absence of "spar" or quartz about the mount, neither is there any indication of lodes; all the tin appears to be volcanic. What the people on the spot term lodes is only large detached masses of volcanic iron and tin lying loose on the clay-slate. The climate is a very severe one, over plenty of snow and frost; roads the very worst I ever saw; surface of the country almost impenetrable scrub of timber.

ON THE PLACE AND MODE OF OCCURRENCE

OF THE MINERAL

ANDREWSITE.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

About a year and a half ago I received from Captain Simmons a specimen which puzzled me a good deal; for, after having determined by means of the blowpipe that it was a hydrous phosphate of iron and copper, I could not find any mention in mineralogical works of a mineral of that composition. At last my attention was directed to a paper by Professor Maskelyne, read in 1871 before the British Association, in which a similar mineral was described. I at once sent some specimens to the British Museum, and Professor Maskelyne recognised some of them as being the mineral Andrewsite which he had discovered two years previously. He had received his specimens from Mr. Talling, of Lostwithiel.

As the mineral is new and exceedingly rare, a few words on the exact locality and mode of occurrence will not be out of place, especially as no locality is given in Professor Maskelyne's paper.

The mineral Andrewsite was found in a tin lode at West Phœnix Mine, near Liskeard. The lode runs about 10° N. of E. (true), and dips south about 60°. The *country* is granite. The lode is 8 or 9 feet wide on an average. There is always a central part of the

lode called the *gossan*, as it generally consists of a soft friable quartz, with ochre. The gossan is 18 inches to 2 feet wide. The hanging-wall part of the lode is made up of a hard compact mixture of Quartz, Chlorite, and Cassiterite, and perhaps other minerals, and is from 18 inches to 5 feet wide. The footwall part is like the hanging-wall part in appearance, is about 3 feet wide, and as a rule is not tinny.

The Andrewsite was obtained from a stope above the 30 fathoms level. At this place the lode contains a great deal of tin and some Limonite; the gossan, too, is very hard and compact, and consists largely of Limonite. The little wavellite-like masses of Andrewsite were found in "vughs" or in crevices in the hanging-wall part of the lode, and I was told by Captain Joseph Hosking, the agent of the mine, that a little Copper Glance had been seen near there. We have therefore two of the elements, copper and iron, for the formation of Andrewsite close at hand; the phosphoric acid was perhaps derived from surface-water that found its way into the lode.

The West Phœnix lode is the same as that which is worked in the adjoining Phœnix Mine, and which has furnished of late years such splendid specimens of Cuprite.

October 30th, 1874.

NOTE.—Since the above paper was written, Professor Maskelyne has published (see *Chemical News*, vol. xxxi., p. 213, 14th May, 1875) his researches on Andrewsite and Chalkosiderite, a "mineral which accompanies Andrewsite in bright green crystals." He has determined their formulæ as follows:

Andrewsite . . . . $4\,Fe_2\,P_2\,O_8 + 2\,Fe_2\,H_2\,O_4 + Cu\,H_2\,O_2$;

Chalkosiderite . . $2\,Fe_2\,P_2\,O_8 + Fe_2\,H_6\,O_6 + Cu\,H_2\,O_2 + 4\,H_2\,O$.

.C8
A2

Royal Geological Society of Cornwall.

Trans. v. 9

THE SIXTY-SECOND

ANNUAL REPORT

OF THE COUNCIL,

WITH THE PRESIDENT'S ADDRESS,

THE TREASURER'S AND LIBRARIANS' REPORTS,

AND

PAPERS AND NOTICES

(FORMING PART II., VOL. IX. OF THE TRANSACTIONS)

READ TO THE SOCIETY.

PLYMOUTH:
W. BRENDON & SON, 26, GEORGE STREET.

1876.

Royal Geological Society of Cornwall.

THE SIXTY-SECOND

ANNUAL REPORT,

ETC. ETC.

PENZANCE.
1875.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

HER MOST GRACIOUS MAJESTY THE QUEEN.

Vice-Patron:

HIS ROYAL HIGHNESS THE PRINCE OF WALES, K.G., ETC.

Trustees:

T. S. BOLITHO, Esq. D. P. LE GRICE, Esq., M.A.
COLONEL TREMAYNE.

OFFICERS AND COUNCIL FOR 1875–6.

President:

WARINGTON W. SMYTH, Esq., M.A., F.R.S.

Vice-Presidents:

THE EARL OF MOUNT EDGCUMBE. SIR JOHN ST. AUBYN, Bart., M.P.
D. P. LE GRICE, Esq., M.A. A. P. VIVIAN, Esq., M.P.

Treasurer:

WILLIAM BOLITHO, Jun., Esq.

Secretary:

GEORGE BOWN MILLETT, Esq., M.R.C.S.

Librarian:

CHARLES CAMPBELL ROSS, Esq.

Curator:

CLEMENT LE NEVE FOSTER, Esq., B.A., D.Sc., F.G.S.

Assistant-Curator:

ANDREW K. BARNETT, Esq., F.G.S.

Council:

THE OFFICERS OF THE SOCIETY.

G. L. BASSET, Esq.
T. ROBINS BOLITHO, Esq.
WILLIAM C. BORLASE, Esq., B.A., F.S.A.
F. G. ENYS, Esq.
CLEMENT LE NEVE FOSTER, Esq., D.Sc.
ALFRED LLOYD FOX, Esq.
THE REV. PREB. HEDGELAND, M.A.
T. ROXBURGH POLWHELE, Esq., M.A.
EDWARD HEARLE RODD, Esq.
WILLIAM H. RODD, Esq.
H. S. TREMENHEERE, Esq., C.B., M.A.
SIR F. M. WILLIAMS, Bart., M.P.

LIST OF MEMBERS, OCTOBER, 1875.

Honorary Members.

George James Allman, M.D., F.R.S., President of the Linnæan Society, M.R.I.A.

Antoine César Becquerel, Member of the Institute of France, Paris.

W. H. Benson, Aix-la-Chapelle.

Henry S. Boase, M.D., F.R.S., F.G.S., etc., Seafield House, Magdalen Road, Dundee.

Ami Boué, M.D., Vienna.

J. Bowman, London.

James Bryce, M.A., LL.D., F.G.S., etc., High School, Glasgow, and Bowes Hill, Blantyre, Lanarkshire.

Josiah P. Cooke, Professor of Chemistry, etc., University of Cambridge, United States.

Bernhard von Cotta, formerly Professor of Geology in the Freiberg School of Mines, Saxony.

John F. Cunningham, F.G.S., 5, Fenwick Street, Liverpool.

James Dwight Dana, LL.D., M.A., Professor of Geology, Yale College, etc., Newhaven, United States.

Auguste Daubrée, Member of the Institute of France, etc., Paris.

Heinrich von Dechen, Oberberghauptmann, etc., Bonn, Germany.

Achille Delesse, Professeur à l'Ecole des Mines, Paris.

Sir Walter Elliot, K.S.I., F.L.S., President Botanical Society, Edinburgh, etc., Wolfe Lee, Hawick.

Rev. Thomas England, F.G.S., etc., North Lew, Devon.

William Henry Flower, F.R.S., F.L.S., F.G.S., Hunterian Professor of Comparative Anatomy, and Conservator of the Museum, Royal College of Surgeons, London.

David Forbes, F.R.S., Sec. G.S., F.C.S., London.

Sir R. J. Griffith, Bart., LL.D., F.R.S., F.G.S., etc., 2, Fitzwilliam Place, Dublin.

Thomas Hawkins, F.G.S.

Sydney Hodges, Torquay.

Robert Hunt, F.R.S., F.S.S., etc., Keeper of Mining Records, 28, Jermyn Street, S.W., and 26, St. Leonards Terrace, Chelsea, S.W., London.

John Edward Lee, F.A.S., F.G.S., Villa Syracusa, Torquay.

Henry McLauchlan, F.G.S., 71, Clapham Road, London.

Léon Moissenet, Ecole des Mines, Paris.

T. Oldham, LL.D., F.R.S., F.G.S., Director of the Geological Survey of India, 1, Hastings Street, Calcutta.
Richard Owen, M.D., D.C.L., F.R.S., F.L.S., F.G.S., British Museum, London, Sheen Lodge, Richmond, Surrey.
Joseph Parker, F.G.S., Upton Cheyney, Bitton, near Bristol.
Charles W. Peach, A.L.S., etc., Edinburgh.
William Pengelly, F.R.S., F.G.S., Lamorna, Torquay.
Lyon Playfair, C.B., M.P., Ph.D., F.R.S., etc., Edinburgh and London.
Frederick Anthony Potter, F.G.S., Takasima Colliery, near Nagasaki, Japan, and 88, Tower Hill, London. E.C.
Joseph Prestwich, M.A., F.R.S., F.G.S., etc., Darent Hulme, near Shoreham, Sevenoaks, and Oxford.
Martyn J. Roberts, F.R.S., Crickhowell, Brecknockshire.
James Tennant, F.G.S., Professor of Mineralogy, King's College, London, 149, Strand. W.C.
Major-General G. B. Tremenheere, R.E., late H.M. Bengal Army, F.G.S., Spring Grove, Isleworth, London.
Major-General Charles Tremenheere, R.E., C.B., H.M. Bombay Army.
W. Wagner, President Wagner Institute, etc., Philadelphia. U.S.
Nicholas Whitley, Truro.

Life Members.

Clement Le Neve Foster, B.A., D.Sc., F.G.S., Truro.
Thomas Adair Masey, F.G.S., 6, Crown Office Row, Temple, London, W.C., and North Cheam, Surrey.
The Earl of St. Germans, G.C.B., Port Elliot, St. Germans.
Warington W. Smyth, M.A., F.R.S., F.G.S., and Foreign Secretary, Chief Inspector of Crown Mines, etc., Museum, Jermyn Street, S.W., and 92, Inverness Terrace, London, W., and Marazion.

Ordinary Members.

Gustavus Lambart Basset, Tehidy, Camborne.
John Hallet Batten, F.R.G.S., 5, Manston Terrace, Heavitree, Exeter.
Captain Bedford, R.N., Penzance.
George Bettany, 5, Brighton Terrace, Dalyell Road, Stockwell, London. S.W.
Henry Blackwell, Penzance.
Francis Boase, M.R.C.S., Penzance.
Edward Bolitho, Trewidden, Penzance.
Thomas Simon Bolitho, Trengwainton, Penzance.
William Bolitho, Polwithen, Penzance.

Richard Foster Bolitho, Ponsandane, Penzance.
Thomas Bedford Bolitho, Trewidden, Penzance.
Thomas Robins Bolitho, Pendrea, Penzance.
John Borlase Bolitho, Trevaylor, Penzance.
William Bolitho, jun., Ponsandane, Penzance.
John Borlase, Castle Horneck, Penzance.
Walter Borlase, Lariggan, Penzance.
William Copeland Borlase, B.A., F.S.A., Castle Horneck, Penzance.
Richard Boyns, St. Just.
John Richards Branwell, Penlee, Penzance.
Frederick W. Brittain, Lanoweth House, Penzance.
S. Chatwood, Chapel Hays, Bodmin.
W. G. Congdon, Marazion.
Thomas Cornish, Penzance.
Rev. Thomas Borlase Coulson, M.A., Buryan, Penzance.
Samuel Henry Fortnon Cox, Lower Carloggos, St. Columb.
John Claude Daubuz, Killiow, Truro.
Richard Davey, F.G.S., Redruth.
Joshua Sydney Davey, Bochym, Helston.
James Dennis, Penzance.
John Dennis, Lower Lariggan, Penzance.
William Dennis, Penzance.
Nicholas Berryman Downing, 8, Highbury Terrace, Highbury, London. N.
Samuel Theophilus Genn Downing, Redruth.
Francis Gilbert Enys, Enys, Penryn.
Richard Eva, Penzance.
The Viscount Falmouth, Tregothnan, Falmouth.
Thomas William Field, Chymorvah, Marazion.
Robert Were Fox, F.R.S., Penjerrick, Falmouth.
Charles Fox, Trebah, Falmouth.
Robert Fox, Falmouth.
Alfred Lloyd Fox, Falmouth.
Charles F. Giesler, 21, Saville Row, London.
Carew Davies Gilbert, Trelissick, Truro.
Henry Grylls, Morton House, Redruth.
Mrs. Richard Harvey, Greenway, Dartmouth.
Christopher H. T. Hawkins, Trewithen, Probus.
Rev. Prebendary Hedgeland, M.A., Penzance.
Samuel Higgs, F.G.S., Wallaroo, Australia.
William Husband, M. Inst. C.E., Hayle.
Stephen Harvey James, St. Just.
Thomas King, Penzance.
Joseph James Lanyon, Penzance.
Day Perry Le Grice, M.A., Trereife, Penzance.

Martin Magor, Penzance.
Rev. J. H. Marshall.
Andrew Harpur Michell, Penzance.
George Bown Millett, M.R.C.S., Penzance.
John Penn Milton, Penzance.
William Mitchell, Penzance.
James Barclay Montgomery, M.D., F.R.C.P., Penzance.
The Earl of Mount Edgcumbe, Mount Edgcumbe, Plymouth.
Samuel Rowles Pattison, F.G.S., 50, Lombard Street, E.C., and Gardner House, Gardner Road, Hampstead. N.W.
Henry Paull, 33, Devonshire Place, London.
Richard Pearce, F.G.S.
Rev. Michael Nowell Peters, M.A., Penzance.
Thomas Roxburgh Polwhele, M.A., F.G.S., Polwhele, Truro.
Jonathan Rashleigh, Menabilly, Fowey.
Edward Hearle Rodd, Penzance.
William Henry Rodd, Penzance.
John Jope Rogers, Penrose, Helston.
John Roscorla, Penzance.
Charles Campbell Ross, Penzance.
Sir John St. Aubyn, Bart., M.P., St. Michael's Mount, and Trevethoe, Lelant.
Rev. Edmund St. Aubyn, Stoke Fleming, near Dartmouth.
Rev. St. Aubyn Molesworth St. Aubyn, Clowance, Camborne.
Bickford Smith, Redbrook, Camborne.
Rev. Ferdinand Stephens, Mawgan.
John Symons, Mayon House, Sennen.
Richard Taylor, F.G.S., 6, Queen's Street Place, Upper Thames Street, London.
William Teague, Trelisk, Truro.
Rev. John Tonkin, Treverven, Buryan, near Penzance.
Colonel Arthur Tremayne, Carclew, Penryn.
Hugh Seymour Tremenheere, C.B., M.A., F.G.S., 43, Thurloe Square, Brompton, London. S.W.
William Trythall, Penzance.
Robert Tweedy, Tregolls, Truro.
Alfred Tylor, F.G.S., Carshalton, Surrey.
Arthur Pendarves Vivian, M.P., Glan Afon, Taibach, South Wales.
Sir Richard Rawlinson Vyvyan, Bart., F.R.S., F.G.S., Trelowarren, Helston.
Nicholas J. West, Hayle.
John Westlake, Q.C., 16, Oxford Square, London. W.
Sir Frederick Martin Williams, Bart., M.P., F.G.S., Goonvrea, Truro.
John Michael Williams, Carhayes Castle, St. Austell.
George Williams, Scorrier.

ASSOCIATES.

Arundel Anthony, Lelant.
James Bennetts, St. Just.
Thomas Blamey, Gwennap.
J. T. Blight, F.S.A., Penzance.
J. H. Collins, F.G.S., Truro.
William Eddy, Pendeen Consols Mine, St. Just.
James Evans, Illogan.
John Giles, Sheffield.
William Gregor, Swansea.
R. T. Hall, Cape Copper Mines, Africa.
William Hollow, Lelant.
W. F. Hooper, Truro.
Richard James, St. Ives.
Benedict Kitto, F.G.S., Redruth.
John Maynard, East Pool Mine, Camborne.
S. Michell, Swansea.
John Nancarrow, Camborne.
Richard Newton, St. Agnes.
Francis Oats, F.G.S., Kimberley, Griqualand West.
John Phillips, Australia.
W. Provis, Dolcoath.
John Rowe, Botallack, St. Just.
Stephen Thomas, Redruth.
Thomas Treloar, London.
Thomas Trezise.
Thomas Treweeke, St. Ives.
Joseph Vivian, Camborne.
William Vivian, Mwyndy, Glamorganshire.
John Way.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

It is a source of gratification to the officers, whom you a year ago entrusted with the direction of your affairs, to observe so full an attendance of members at the annual meeting. We see therein a proof of a widely-felt interest in the aims and the welfare of the society, which we gladly meet, in the outset, with an assurance of a state of prosperity, as to numbers and financial position, superior, as I am given to understand, to anything hitherto known in your history. May we hope that this interest will gradually induce more of our members, and other dwellers in the county, to dive deeper into the cognate studies of mineralogy and geology, to utilize your ever-improving library and collections, and to join in those researches for which our Western counties offer so fine a field, and in which our predecessors, assembled, though with fewer advantages, in this remotest of Western towns, have set us so excellent an example.

The events of the past year have led me, with unusual pressure of sorrowful thought, to a retrospect extending far back towards the first years of activity of this Society. We have, within a few months, lost from our list, besides other honoured members, two men of such eminence, two examples of such peculiar powers in our especial line of study, that I need make no apology for occupying a not inconsiderable portion of your time this morning in recalling some of the prominent traits, for which they claim our admiration, and the gratitude of all friends to the advancement of knowledge.

The death of William Jory Henwood, on the 5th August last, has robbed us of a colleague who, though for some years he appeared but little among us, took, nevertheless, a deep interest in

this Institution, and who, by his labours of research and description, continued over fifty years, has had the lion's share in making your *Transactions* known and respected, even to the uttermost corners of the earth.

He was born at Perran Wharf in 1805, and in his first youth was engaged for some years as a clerk in the office of Messrs. Fox and Co. Here he had the advantage of occasional intercourse with our veteran and respected associates, Robert Were Fox and Charles Fox (the latter of whom, your former President, we are glad to welcome among us this day), who, finding in their employé a decided taste for scientific investigation, united in proposing to him to make a series of systematic observations in some of the mines. These were commenced in 1826, and were directed to the collecting of facts connected with the geology of the rocks and country of the lodes, their temperature, and the deposition of the ore in them, and the question of how far this deposition was more or less definite in the rocks which the veins traversed.* Henwood readily acceded to the proposal, and industriously took in hand the observations, the Messrs. Fox having, with the assistance of a few friends, placed suitable funds at his disposal. The manifestly valuable character of the object subsequently attracted more general attention; and many persons in other parts of the county subscribed, to enable him to carry on his researches in the mines on a more extended scale.

How he executed his task is best shown by vol. v. of the *Transactions*, entirely occupied by his observations and their tabulated results, a pile of labour which none can fully appreciate, except those who go down into the depths, and test for themselves the manifold difficulties of the position. These materials were in part read before the Society at various dates, from 1830 onward; and were at length published together in 1843, the result of fourteen years' investigations.

It is unnecessary to recall to your memory the particular qualities of this book; but we may remark among its best features that conscientious exactness of observation, and that scrupulous

* MS. communication from Miss Fox, on the part of R. W. Fox, F.R.S., September, 1875.

reference to all previous authors on the same subjects, which have characterized all his publications. Another point is, that having engaged to collect facts, he has most studiously recorded them; and has, in a careful and self-denying way, abstained from those generalizations and theories which are so apt to occupy the attention of, and sometimes fairly to run away with, authors engaged in the furtherance of a new and progressive branch of science.

Mr. Henwood's merits had, in the meanwhile, not been overlooked outside the walls of the Geological Society. He received, in 1832, the appointment of Assay-master and Supervisor of Tin for the Duchy of Cornwall; and when the coinage duties were abolished, in 1838, retired from that office with a pension. He was also elected a Fellow of the Royal and the Geological Societies of London. His numerous smaller works, in the shape of papers contributed to various periodicals, had by this time drawn attention to the earnest and practical spirit and the perseverance with which his researches were carried out; and no sooner was his bulky volume completed, than he was engaged to take charge of gold mines in Brazil. Ten years spent in that auriferous district supplied our late associate with opportunities of observation in a new field; and a mission afterwards to upper India, for the examination of the deposits of copper and iron ores in Kumaon and Gurwhal, with visits to other localities for similar purposes, afforded him a mass of materials, which occupied many years in digesting and reducing to order. As you all know, he selected Penzance for his dwelling-place; and retiring in 1858 from active life, he added to his own observations a vast mass of instructive matter, culled from an extensive course of reading; and at length published the results in the eighth volume of your *Transactions*, completed in 1871. His election to the Presidency of the Royal Institution of Cornwall, in 1869, was the occasion of his preparing addresses of remarkable value; one of these was an epitome of the characters of lodes, or mineral veins, in which the subject is treated in a far more readable form than in his larger works; a second consisted of observations on the stream or detrital tin-ore of Cornwall. The last-mentioned *brochure* was brought out in 1873; and in presenting me with a copy of it he remarked, that with this he

concluded his work; for he felt that a disease of the heart, upon which he had years before had medical advice, was now increasing upon him, and would probably give him but a short respite. From the nature of the disorder, both himself and his friends were prepared for the suddenness with which his life was terminated, in his 71st year.

Mr. Henwood had, of course, like other mortals, his foibles; and a quick temper, united with a tenacious memory and strong satirical bent, were the cause of animosities, which unfortunately deprived us of the advantage of his aid in the working of your Council. But he was, nevertheless, always ready to give information when asked for it; and would then appear to know something of every book, and specimen, and member that had ever belonged to the Society. Of him it might be said that

"He had strange places crammed with observations."

Nor was his range limited to ourselves, or to the county of Cornwall. Imbued with a true philosophic spirit, *contentus parvo*, loving science for its own sake, and supported by his deep religious convictions in bearing the painful trial of his illness, he kept a watchful eye, through diligent perusal of the scientific periodicals, upon all that was going on in connection with the favourite studies of his life. He had in this way formed very just estimates of the value of the leading observers and authors of the last forty years; and if he held genius and true knowledge in the highest esteem, equally strong, at least, was his dislike and contempt for the pretender.

These good qualities, notwithstanding his living in comparative retirement, were widely appreciated; and the last half-year of his life was cheered by the award to him of the Murchison medal of the Geological Society of London.

That Mr. Henwood always had really at heart the well-doing of the local body to which in early years he owed so much, has been additionally proved by the bequest of £100, which he has left to this Society, unfettered by any conditions.

It is, finally, a subject of satisfaction to myself that, by fortunately learning when and where the funeral was to take place,

notwithstanding his whimsical directions for keeping it strictly private, I was able, as the sole member there, to represent the Society with which he had so long been honourably identified. And as I stood by his simple grave in the rustic little churchyard of Perran Arworthal, I could not but feel that we were committing to earth the remains of a man of rare qualifications—of one who well deserves to be classed among the worthies of the county he loved so well.

Sir Charles Lyell, Bart., died on the 22nd February, of this year, in his 78th year, from the infirmities of age, aggravated by the effects of a fall on his stair; and, to the great sorrow of all who knew him, has thus closed the long career of intellectual usefulness which had made his name a household word in every clime. No one among us is unacquainted with the high reputation of our deceased honorary member; but since the peculiar drift and merits of his work may not be so generally known, you will, I feel sure, not regret that I should dwell for a time on the characteristics of so great a master, so eminent an example to those who follow, and one of whom I can speak from the heart, having had the advantage of regarding him as a cheerful and sympathetic friend from my earliest boyhood.

Born the eldest son in a well-to-do Scottish family in Forfarshire, Charles Lyell studied at Oxford, and then proceeded to London to enter the bar. But it was soon clear that, however much the laws of nature were to his taste, those of man had no attraction for him. More and more he read and pondered upon geology and its allied subjects; and ere long he broke away from the thraldom of his legal pursuits, and somewhere about 1820, when locomotion still involved time and trouble, was making long tours in and about the classic waters of the Mediterranean. Here it was that my father, then in command of H.M.S. *Adventure*, met with the young barrister industriously examining and taking notes of every variety of natural phenomena. Shells, bones, and minerals, fossils, rocks, and plants, up to then commonly considered in those parts the legitimate objects of the "collector," were now mingled up with enquiries into sand-banks, marine currents, volcanic action,

winds, and human history. A web, however, was being woven in the observer's mind, which was gradually to connect in one fabric all these diverse subjects of interest.

So for a number of years Lyell studied, observed, noted, and worked out his conclusions; brought many of the questions before the Geological Society of London; gave some lectures to elucidate his views; and at length, in 1830, brought out the first volume of the first of a long series of editions of his *Principles of Geology* This work, which has from time to time changed no less its contents than its outward form, advancing with the collection of fresh facts and the progress of scientific thought, is that which chiefly embodies his particular doctrines, and upon which his fame is mainly founded.

It has been alleged that Lyell's views were not new; and Scotchmen have claimed for Hutton, and Germans for some of the Teutonic authors, the merit of having long ago brought similar ideas before the world. But no one can pretend to have explored, as he did, every road and bye-way in search of illustrations to give force to his arguments; and no one has approached him in the influence which he acquired, and the scope and direction which he gave to the current of philosophic thought throughout the cultivated world. Lyell's great object was to show that the causes operative in the formation of the earth at past periods were precisely the same as we may see in work around us at the present day. For the purpose, therefore, of reading the early history of our globe, we must first obtain thorough knowledge of the working of nature as we may glean it from actual observation, and from the records of history. The gauntlet is thus thrown down before those who advocated a greater intensity of action in the past, and especially challenges those who have imagined a history broken in upon at frequent intervals by catastrophes of wide-spread destruction, and chaos come again. It is but a few years ago that, on the lips and in the written words of men of high ability, the opinions he combated were quite common; nay, they are not unfrequent still. But our Reform Bills of politics have not been half so efficacious in eradicating storms and violence as have the strict logic, the abundant illustration, and the attractive language of Sir Charles Lyell in

dispelling the notions of "convulsions of nature" so prevalent before his advent.

Let me suggest, in the physical branch of our subject, an instance or two of what must strike every mature observer of mankind as a change of thought which has taken place in his own time, and which he will find hold good throughout instructed Europe and America. You met with a bold hill of somewhat unusual shape—never mind whether of stratified or of crystalline rock—its form and origin were sure to be set down to some protrusion or eruption from among the neighbouring masses, or ascribed vaguely to the "convulsions of nature." Or again, as in Derbyshire or the Alps, you visited a narrow valley, its craggy sides jutting into peaks above, and closing to within a few yards below, perhaps in a green meadow, or in the bed of a swift stream throwing itself impetuously from one side to the other of its rock-bound prison. Here you were bidden to gaze with horror on the frightful disruption of the earth, produced in past times by subterranean violence. The correspondence of the strata on opposite sides, the way in which angles in the valley-course fitted one another, and cavern on one side of the glen answered to its continuation on the other—all these would be appealed to as the clearest evidence of the chasm having been rent asunder through the solid rocks by stupendous agencies, the like of which have never been known to mortal man.

We owe it in a high degree to the teaching of Lyell that these mistaken notions have passed away, and that we can now trace most of the gigantic phenomena, of which geology takes note, to the slow action of existing causes exerted over long periods of time.

Some may, perhaps, be inclined to urge that by this "levelling down" to the scale of our own times a part of the romance attaching to the subject is lost. They may argue that mystery and acts of violence are as attractive in the history of the earth as in novels and newspaper literature. But truth is the end and aim of our investigations; and if a part of the interest be considered in this way weakened by the doctrine of Lyell and his Uniformitarian school, it has amply been made up in another direction. In the early years of this century, geology was in a great measure a dry

enumeration of rocks and minerals, with occasional jejune details as to superposition and direction of mountain chains. It is to Lyell that we are indebted for proving that the phenomena of geology are most closely connected with all the other sciences, that in order to judge of the past we must turn to every side with the closest study of the present, and that we are living in a world of beauty and interest where no spot of land and no subject is so trivial but what it affords to the mind of the philosopher matter for enquiry and connection with other pages of the great book of nature.

The deeply-absorbing history of life on the globe, though our present knowledge of it may be but rudimentary, has in great part been brought up to its present state of advancement within the period of Sir Charles Lyell's labours; and our late honorary member took a leading part in observing, classifying, and reasoning upon its mysterious problems. The earlier views of the entire extinction from time to time of the old and the creation of new groups of organic beings were at first admitted, and then afterwards entirely displaced by him. And singularly may his powers of mental assimilation and his courage be inferred from a perusal of the successive editions of his *Principles.* Originally a staunch supporter of the definiteness of *species* in the organic world, and a stern opponent of theories of development, he no sooner studied and felt the force of the views of Darwin than he yielded up his old opinions as untenable. Arrived, too, at an age when most men find it hard to change old beliefs, he embraced with the spirit of a youth the new views which have been accepted by the majority of naturalists, and skilfully interwove them with the thread of his general argument.

Almost as well known as his *magnum opus,* his chief literary work, are the *Elements of Geology,* a text-book which has passed through many editions, and the *Antiquity of Man;* but no one can form a full estimate of the unwearied industry of Lyell as a collector and collator of facts who does not follow out his literary history, as exhibited in smaller works and communications to societies, in his labours with Deshayes among the Tertiary shells, and in his visits to different parts of Europe, for the purpose of

working out some particular enquiry. Nor can one omit to remark that in all the researches of his life, after the full publication of the *Principles*, he enjoyed the advantages of the sympathetic intelligence and zealous co-operation of his accomplished wife, the daughter of Leonard Horner; for Lady Lyell united to her feminine grace an unusual judgment and acquaintance with sundry branches of natural history.

We should not derive the lesson which we ought to learn from a brief review of the career of this eminent man, were we to leave unnoticed one of the characteristics which in a high degree contributed to that eminence. I do not come before you to-day as a critic of his work, nor do I stay to enquire whether his doctrine of Uniformity in the action of Nature has not been carried too far, both by himself and many of his followers. We may have our serious doubts whether the physical agencies which have modelled the face of our globe have always produced "equal effects in equal times;" but we may nevertheless feel assured that intellectual activity, and the status of scientific thought, have been greatly benefited by the long-continued efforts of our deceased associate. We have seen that he took a wide grasp in his harvesting of natural phenomena; but amid all that seemed to be diverse and multifarious, there always appeared to be a unity of purpose. Whatever he heard, or read, or saw, he always sifted and considered as to its bearing on his views of geology, and regarded it in the light of a something which ought to lead to an amplification, or a correction, or a modification in his next edition. No longer ago than the 20th September, 1873, having heard from me about the new excavations for stream-tin under Restronguet creek, he wrote me: "If you "learn anything more about the old men of the tin-ground and "buried estuary in Cornwall, do not forget to tell me. I flatter "myself I have got a good many new ideas, which I shall try to "get into the new edition of my *Student's Elements;* but I hope "I shall not forget how much the success of such a book may "depend on its price, as I remember on a former occasion the "publisher, when speaking of the *Elements* in its older form, said, "'The more you improve it the less it will circulate.'"

This thirst for fresh facts was ever upon him; in private or in

public he was always alive to whatever might be regarded as an addition to knowledge, whilst with a rapid stroke of thought he at once saw where it would suit him for adoption. And a persistency, such as one has rarely, if ever, witnessed in any other man, a settled purpose in always aiming at particular objects, added to his other qualifications, ensured for him that success which in life gave him admiration and fame, in death obtained for him universal regret, and the honours of Westminster Abbey.

More closely connected with the county was one of our other members lost to us, Sir Edward Smirke. Many years have elapsed since he was appointed, at the recommendation of Sir William Follett, standing Counsel to the Duchy of Cornwall. In process of time he became Solicitor and then Attorney-General to the Prince of Wales; and ultimately, on the death of his friend Mr. Dampier, was appointed Vice-Warden of the Stannaries. He was thus brought closely into contact with Cornwall; and residing a good deal at Truro during the seventeen years for which he held the office, took a leading part in the work and the excursions of the Royal Institution. He conferred a great boon upon those of us who are interested in the tin trade of Cornwall by the diligence and acumen brought to bear, in sundry books and papers, on the ancient charters of the tinners, and on the law of property in mines generally, during the middle ages. I may refer especially to his elaborate appendix to the case Vice *v.* Thomas, heard before the Lord Warden in 1843, a storehouse of archæological lore, which has been turned to good account by our late Hon. Secretary, Mr. W. C. Borlase, in his interesting *Historical Sketch of the Tin Trade.**

We regret also to have lost from the roll of the Society Mr. Reginald Paynter; Mr. J. Symons, of Sennen, one of our oldest members, who had, in fact, been connected with it for fifty-seven years; and Mr. E. Davenport, M.P., one of those who had most recently joined us, and who, had he lived, promised to be a useful worker in our body.

I may now say a few words on the present condition of your collections. The zeal of the Hon. Curator, Dr. Foster, has enriched

* Plymouth: W. Brendon and Son. 1874.

the mineralogical series with a goodly list of new specimens, some of them of kinds of which we had no examples before; others of them (and this I think a very important matter) exhibiting occurrences which are either new to the county, or to particular localities in it. The catalogue which, with the aid of Mr. Barnett, he has lately prepared, and which the Society has printed, is of a very popular character; and being sold to visitors at a very low price, will, we hope, spread abroad a rational interest in the objects presented to view in the cases of the museum. The collections in the fossil-room downstairs must still be regarded as in a transitional, we will not say an embryo, state; for the gratuitous work done by Mr. Bettany, jun., has been supplemented by that of Mr. Kitto, who has commenced a re-ordering and labelling of the older fossils, which we hope will soon be carried out more extensively. The Society possesses a large store of additional specimens to be incorporated; but before we can look upon the museum in that department as doing justice to the scope of the institution, and being of that educational value which we should like to see impressed upon it, a good deal remains to be done. It will be desirable that additional cases be placed either against the wall, or in front of the windows; and I think no satisfactory stride towards completion can be taken until we can pay for a few weeks' work some competent authority in palæontology, and through such a person purchase some of the more important specimens to fill up our deficiencies.

Another matter of domestic interest is the success of the classes which have been studying under Mr. A. K. Barnett, your Assistant-Curator, and turning to account, under the permission of the Council, some of your unoccupied rooms on the basement. You are aware that the test of these studies is the examination under the Department of Science and Art. Mr. Barnett has handed me the names of thirteen students, and I find the following results: that eight of them obtained, in May last, a first-class in Chemistry; three a first-class, and three a second in Mineralogy; two a first-class, and two a second in Elementary Steam; and one a first-class, and three a second in Elementary Metallurgy. These figures speak for themselves; and whilst they do much credit to Mr. Barnett and his class, cannot be otherwise than satisfactory to the Society, which

provides them with a "local habitation," and for some of their subjects, a fine series of illustrative specimens.

I have to express the satisfaction which we feel at the publication of part i. of vol. ix. of your *Transactions*, containing the papers read before the last annual meeting. We hope in future to be able each year to issue in print the reports and papers within a short time of their being read.

For the last three years a geological experiment on a bold scale has been carried on near Battle, in Sussex, the real object of which has been so misunderstood by a part of the public that it ought to be set forth clearly to every meeting of geologists. I must not detain you by discussing the speculations of various authors on the nature of the rocks which lie beneath the surface deposits of the south-east of England. The object with which this subscription work was commenced cannot be better described than in the words of our late hon. member, Prof. Phillips, written soon after its commencement: "Not to dig gypsum, not to open a new supply of salt, not to discover coal in Sussex, but to find out what is below the Wealden, and thus contribute to solve a great practical problem for London and all the South of England, have geologists undertaken the deep boring near Hastings. What is below the Wealden? Do the Oolitic rocks continue beneath it with their usual character and thickness? or do they suffer that remarkable diminution which is observed in their eastward declination through the midland counties? Do they occur at all there? may they lie only in separate patches amidst older rocks? may these older rocks, continued from Belgium, appear at once or at no great depth below the Wealden, and bring with them, if not coal, some sure knowledge of the way in which the great subterranean anticlinal passes from the Rhineland through Belgium to Somerset, South Wales, and Ireland?"

The boring was begun with a diameter of nine inches, with iron rods and a percussive cutting tool; afterwards it was taken in hand, under contracts, by the Diamond Boring Company; and, with both methods, this undertaking has added another example of the breakages, and delays, and unexpected costs of this kind of exploration at considerable depths.

The hole, a new one put down by the last-mentioned company, began with a diameter of eight inches, which, at 1,762 feet, was reduced to 2⅛ inches. At about this depth it appears that the base of the Kimmeridge clay was reached; and the main point proved is, that instead of these Jurassic beds thinning out, as was expected by many, on their way towards the channel, they attain a thickness near Hastings of hundreds of feet more than was known anywhere else. And although it was proposed at the time of the last quarterly report to try to get down a little deeper, the interest of the question is almost gone, since it has been shown, by the result already attained, that with so vast a mass of these argillaceous beds underlying the Wealden, and with the probability of the lower Oolitic beds being in normal force, the chance of coming down to the Palæozoic rocks, at less than 3,000 or 4,000 feet, is extremely small.

Another event of the year, connected with deep exploration of the earth's crust, is more striking and of more interest to us whose lot is mainly cast among the more ancient rocks. Invitations were recently issued by the Austrian government to all nations to send mining representatives to fêtes appointed for the 13th, 14th, and 15th of September last, to celebrate the sinking of the main shaft, Adalbert's, at the silver-lead mines of Przibram, in Bohemia, to the amazing perpendicular depth of 1,000 metres, or 3,280 English feet, being 546 fathoms, four feet. The guests were invited, as a part of the programme, to inspect the workings, as well as the dressing and smelting works and machinery, connected with these noble mines; and as a descriptive notice was to be prepared, I was engaged in a correspondence with some of the officers there as to deep mines in England and in Belgium. It resulted that, as a fair perpendicular sinking, this shaft at Przibram was after all not the deepest in the world. Statements, but somewhat confused ones, had been made about a coal-pit in Belgium, said to be above 1,000 metres deep; and as the result of the discussion has been to give me full particulars of this notable, though unsuccessful, sinking, I exhibit a section of the shaft and the strata for some little distance from it.

The vertical shaft called *Simon Lambert*, at Gilly, near Charle-

roi, is a circular one, three metres (or 9·6 feet) in diameter. After working certain upper seams of coal in very contorted country, it was sunk, along with a companion shaft, to 861 metres (2,824 feet), where some horizontal levels were driven; and then continued, by aid of a succession of windlasses, as an exploring shaft, to the depth of 1,065 metres, or 3,493 feet English (or 582 fathoms). Below this a bore-hole of 15 metres was put down, making the total depth proved 1,080 metres, or 3,542 feet.

The deep measures thus pierced were so barren of workable coal, that further trials were not attempted; and the mine is only kept drained to the 861 metre level.

On a rough diagram I have represented these two very remarkable shafts, and, for comparison's sake, have placed alongside them, on the same scale, our deepest English coal-pit, and the depth of Dolcoath mine, where I learn this day, from Capt. Josiah Thomas, that the perpendicular depth, from surface to the so-called 326 fathom level, is 322 fathoms, whilst, if measured along the underlie up to the adit, and adding 26 fathoms from adit to surface, the total is 352 fathoms.

These depths, that look like a mere scratch to the cosmogonist, whose eye is filled with the measurement of the radius of the globe, look formidable enough to those who have to count the cost of all the operations connected with the sinking; and my chief reason for bringing the matter before you is, to aid in commemorating a great mining fact, and to give confidence to those engaged in deep mining, by adverting to the continuous and great prosperity of the deepest metalliferous mine in the world.

REPORT OF THE COUNCIL.

In presenting their Sixty-second Annual Report, the Council have the satisfaction of once more congratulating the Society upon its continued well-being and increasing usefulness.

Early in the present year the last Annual Report was printed, and circulated among the Members of the Society; and it is proposed for the future to issue the Reports, together with the *Transactions*, as quickly as possible after the Annual Meeting.

Part i. of vol. ix. of the *Transactions* is completed, and has already been largely distributed among the Members and learned societies at home and abroad. This portion of our publications includes the papers read at the last Annual Meeting; therefore, the whole of the scientific communications which, up to the present time, have been received by the Society, and adopted by the Committee of Papers, are in print, and in the hands of the public.

The thanks of the Society are especially due to our late Secretary, Mr. Hallet Batten, who, in the absence of his successor, Mr. William C. Borlase, on a tour round the world, kindly undertook the editorial duties, and has now brought them carefully and successfully to a close.

The Forty-fourth and Forty-fifth Annual Reports, which, in consequence of having been to a great extent accidentally cancelled, were unusually scarce, have recently been reprinted, and are now available for members and others who have hitherto been unable to complete their sets of the Society's publications.

It is a source of gratification to the Council to allude to the continued success of the Science Classes, conducted by your

Assistant Curator, Mr. Barnett, in connection with the Miners' Association.*

The Librarian's Report will inform you that particular attention has been paid to the binding of periodicals during the past year. It may be mentioned that several persons from a distance have lately journeyed to Penzance for the purpose of consulting books in our Library; and by way of extending its usefulness, a grant of £15 has this day been made by the Council, to be expended partly in further binding, but more especially in the purchase of modern scientific works, very few additions having been made to its shelves of late years.

That very satisfactory progress has been made in the Museums will be evident from the Report of your Curator, who himself

* The following particulars were communicated by Mr. Barnett, through the Treasurer:

Penzance, 28th October, 1875.

Royal Cornwall Geological Museum Science Classes.

DEAR SIR,

I have to report, with reference to the application I made to the Council of this Society about twelve months since, for aid towards the purchase of apparatus, &c., for the classes then formed in "Chemistry," that, with the concurrence of the Council, I applied to several gentlemen connected with the Society for a donation. I received in response to my appeal—

	£	s.	d.
Subscriptions from Members of the Society . . .	11	10	6
To receive (subscriptions promised, not collected) .	2	0	0
Council of the Royal Cornwall Geological Society .	5	0	0
Penzance Town Council, through Mr. W. H. Rodd .	5	5	0
	£23	15	6

This result was so far beyond my estimate of the amount required, that I was enabled to purchase a more complete set of apparatus than I at first intended. The gaining of a "laboratory" grant by *each* successful student in Chemistry at the last examinations points to the utility of the apparatus purchased, which was used for experimental chemistry.

The classes in Chemistry and Mineralogy were resumed last month, besides which I have this year organized a class in "Geology." The attendance continues good, and I hope that at the next examinations the number of passes will point to a steady improvement of the classes. Owing to Mr. Jago's removal to London, the classes in Steam and Metallurgy have been discontinued.

I am, dear sir, yours respectfully,

A. K. BARNETT.

W. Bolitho, jun., Esq., Treasurer Royal Cornwall Geological Society.

presents a very large proportion of the remarkably interesting specimens displayed upon the table to-day. A grant of £25 has now been made for the further fitting up with wall cases of the Fossil Museum, and a smaller sum has been voted for the purchase of specimens. *The Guide to the Museum* which was suggested in a former Report, has, some months since, been completed by Dr. Foster and Mr. Barnett. It has been published in a popular and convenient form, and many dozen copies have been sold to visitors at the price of one penny each, or distributed among the Members.

Not less than six hundred persons have entered their names in the visitors' book; but very many more must have visited the Museum during the past twelve months.

Since the last Annual Meeting the Society has been deprived by death of one of its oldest, ablest, and most valued Members, William Jory Henwood, F.R.S., F.G.S., Member of the Institution of Civil Engineers, Member of the Geological Society of France, Honorary Member of the Yorkshire Philosophical Society, Corresponding Member of the Plymouth Institution and of the Lyceum of Natural History of New York, Her Majesty's Assay-master and Supervisor of Tin in the Royal Duchy of Cornwall from 1832 to 1838, President of the Royal Institution of Cornwall in 1870 and 1871, and some time Secretary and Curator of this Society. He was born at Perran Arworthal, near Truro, on the 16th January, 1805, and died at his residence, 3, Clarence Place, Penzance, on the 5th August, 1875.

In three score years and ten few have done so much for the subject which he made his peculiar study; none have excelled him in it. He was the writer of altogether not less than one hundred contributions to scientific knowledge (varying in length from a few lines to more than 900 pages), the most important of which were published under the auspices of this Society, notably vols. v. and viii. of its *Transactions*, and the titles of all, or nearly all, will be found occupying just seven columns in the *Bibliotheca Cornubiensis*. The shelves and cases of this Museum, too, bear witness to his industry and zeal. Untiring in the pursuit of knowledge, and indefatigable as an author, it is not surprising that his reputation is world-wide. He

received the Telford Medal from the Institution of Civil Engineers in 1837, and as lately as the present year the Murchison Medal of the Geological Society of London.

His works will perpetuate his memory far more fittingly than an elaborate obituary notice—the thought of which indeed was intensely distasteful to him, and it is unnecessary to attempt one here —but it would have been impossible for the Council of the Royal Geological Society of Cornwall to have met the Members without dwelling to some extent upon the very severe loss which has been sustained in the death of Mr. Henwood. In a letter written to your Secretary not many weeks before his decease, he says: "More than half a century has passed since I communicated my first paper to the Society, and from that time to this I have been an occasional contributor to its publications." He adds, "I still feel as warm an interest as I ever felt in its success;" and in proof of this it now becomes the duty of the Council to announce that he has bequeathed to the Society the sum of one hundred pounds, free of duty.

Mr. Reginald Paynter, of Boskenna, who but recently joined the Society, was also suddenly removed by death at the commencement of the present year; and as lately as the 20th inst. Mr. Symons, of Mayon House, Sennen, passed away, one who first became a member of the Society in the year 1818.

Among our honorary Members we have to lament with the world at large the death of Sir Charles Lyell; and in Sir Edward Smirke we have lost a distinguished man, long connected with this county.

In conclusion, the Council desire to recommend the undermentioned gentlemen, who have been duly proposed for election, as ordinary Members: Dr. James Barclay Montgomery, of Penzance; the Rev. Thomas Borlase Coulson, of Buryan; and Mr. Carew Davies Gilbert, of Trelissick.* Also, as honorary Members, James Dwight Dana, LL.D., M.A., Professor of Geology and Mineralogy at Yale College, Newhaven, United States, &c., author of several

* The following gentlemen were also proposed as ordinary Members at the annual meeting, and together with the above were elected; viz., Mr. Alfred Tylor, F.G.S., Carshalton, Surrey; Mr. John Westlake, Q.C., 16, Oxford Square, London; Mr. John Symons, Mayon House, Sennen; and Mr. John Roscorla, of Penzance.

valuable works on Geology and Mineralogy; Auguste Daubrée, Member of the Institute of France, &c.; and Heinrich von Dechen, Chief of the Mining Department in Rhenish Prussia, &c., &c., both of whom are voluminous writers; and as Associates, Captain John Maynard, Manager of East Pool Mine, and Mr. Benedict Kitto, F.G.S., &c.

GEORGE BOWN MILLETT, *Secretary.*

Oct. 29th, 1875.

LIBRARIAN'S REPORT.

THE Annual Meeting last year passed a resolution to the effect that a sum not exceeding £10 should be spent on binding some of our more valuable works. We have accordingly bound the *Annales des Mines*, and the *Quarterly Journal of the Geological Society*, up to the end of 1874, about forty volumes in all.

The *Transactions of the Palæontographical Society* are now in the binder's hands, and will, we hope, shortly be ready.

As the funds of the Society will allow it, the further grant that has been made to-day for the ensuing year is very opportune, as there is still a large number of volumes requiring to be bound, and now lying practically useless in our cupboards; it is also very desirable to make some additions to our Library in the shape of modern standard works, which are at present greatly wanted.

AUTHORS' PRESENTATIONS.

Remarques sur le Minerai d'étain détritique du Cornouailles. Par W. Jory Henwood. (Extrait des Annales des Mines, vol. vi., 1874.)

Principles of Metal Mining. By J. H. Collins, F.G.S.

Carte Agricole de la France. By M. Delesse, Professeur à l'Ecole des Mines, &c. &c.,

The Origin of the Chesil Bank and Notes on the Isle of Portland and around Weymouth. By Joseph Prestwich, M.A., F.R.S. Professor of Geology at the University of Oxford.

The Rocks of the Mining Districts of Cornwall, and their Relations to Metalliferous Deposits. By J. Arthur Phillips, F.G.S., &c.

Monographs xviii. and xix. From the Proceedings of the American Academy of Arts and Sciences. By J. P. Cooke, jun.

Notes on Drift Soil of Minnesota. By W. H. Winchall.

On the Hamilton in Ohio.

Devonian Limestone in Ohio, &c From the same.

Ocean Currents. By James Croll, of the Geological Survey of Scotland.

Discours prononcé au Caire à la séance d'inauguration, de la Société Khédiviale de Géographie, 2 Juin, 1875. By Dr. G. Schweinfurth.

Statuts de la Société Khédiviale de la Géographie. By Dr. Schweinfurth.

Cornwall and Devon Mining Directory. By Jas. Williams.

The Ores of Iron: Considered in their Geological Relations. By the President, Warington W. Smyth, F.R.S., F.G.S., &c., &c.

OTHER PRESENTATIONS.

The Geological Magazine. Vol. xi. 1874. Presented by Mr. W. J. Henwood, F.R.S., &c.

Seven Reports, with Maps, on the Geology, &c., of the Island of Newfoundland. Presented by Commander Howarth, R.N., through the President.

The following were presented by the University of Christiania:

Om skuringsmærker, glacial-formationen, terrasser og strandlinier samt om grundfjeldets og sparagmitfjeldets mægtighed i Norge. II. Sparagmitfjeldet. By Professor Theodor Kjerulf.

Norges Officielle Statistik Udgiven, 1 Aaret, 1874. Tabeller vedkommende Norges Berkværksdrife, 1 Aarene, 1866–70.

Jættegryder og gamle Strandlinier i fast Klippe. By S. A. Sexe.

Bereting om nogle Undersögelser over Sparagmitkvarts-Fjeldet i den ostlige Deel af Hamarstift. By O. E. Schiötz.

Om Kromjernsteen i Serpentin, &c. By Amund Helland.

Gletscher Experimenten. By S. A. Sexe.

The Ground Beneath us. By Joseph Prestwich, F.R.S. Presented by Dr. C. Le Neve Foster.

Catalogue of Books in the Penzance Public Library. Presented through the Secretary.

United States Geological Survey. Miscellaneous Publication. By F. V. Haydon, U.S. Geologist in Charge.

1. List of Elevations in that portion of the United States West of the Mississippi River. H. Garnett, M.E.
2. Report of the Geological Survey of the State of the Missouri, with Atlas, including Field Work of 1873–74. By G. C. Broadbent, State Geologist.
3. Birds of the North West. By Elliott Coues.

Abstracts of the Reports of the Weather at Penzance and Neighbourhood, for the years 1871–4. By Mr. W. Hosken Richards.

REPORTS, &c.

THE following Reports, Transactions, Proceedings, Magazines, &c., have also been received:

Reports of the Mining Surveyors and Registrars of Victoria, &c.

Reports of the Chief Inspector of Mines for Victoria, Australia.

Proceedings of the Geologists' Association.

Annales des Mines.

Proceedings of the American Philosophical Society.

The London, Edinburgh, and Dublin Philosophical Magazine.

Abstract of the Proceedings of, and the Quarterly Journal of, the Geological Society of London.

Smithsonian Contributions to Knowledge.

Smithsonian Miscellaneous Collections.

Proceedings of the Royal Society.

Transactions of the Manchester Geological Society.

Proceedings of the Literary and Philosophical Society of Liverpool.

Proceedings of the Royal Society of Edinburgh.

Records of the Geological Survey of India.

Records of the Palæontologia Indica.

Reports and Proceedings of the Miners' Association of Cornwall and Devon.

Transactions of the Royal Society of Victoria.

Proceedings of the Bristol Naturalists' Society.

Bulletins and Reports of the United States Survey of the Territories.

Catalogue of the Publications of the United States Survey of the Territories.

Reports of the Geological Survey of Ohio.

Proceedings of the American Philosophical Society.

Proceedings and Transactions of the American Philosophical Society.

Proceedings of the American Academy of Arts and Sciences. Vols i. and ii. New series.

Annual Report of the Smithsonian Institution.

Report of the United States Geological Survey.

Jaarboek van het Mijnwezen in Nederlandsch Oost-Indië.

Archiv für die Naturkunde Liv-Ehst-und Kurlands.

Sitzungsberichte der Dorpater Naturforscher-Gesellschaft. 1873–4. By Dr. Arthur von Oettingen.

CHARLES C. ROSS, *Librarian.*

29th Oct., 1875.

CURATOR'S REPORT.

In my report last year I promised to bring out a small Guide to the Museum for the use of visitors. With the aid of my assistant, Mr. A. K. Barnett, F.G.S., this has been accomplished, and the Guide, price one penny, was ready in the summer. As stated in a note, this Guide is merely a provisional one; as soon as the Fossil collection is tolerably complete, and the specimens in the Wall-cases are re-arranged, another will be published. In the meantime, the present Guide is amply sufficient to give a general explanation of the Minerals, which form the most important and attractive part of the Society's collections.

Very little has been done in the Fossil Room; indeed, without additional cases, it will be impossible to exhibit a proper collection of typical British fossils, or even the numerous Cornish specimens that we possess. With the permission of the Council, I obtained the services of Mr. Benedict Kitto, F.G.S., to arrange some of the Cornish Silurian and Devonian fossils. Case VII. and part of VIII. have been put in order, and the specimens clearly and distinctly labelled; in all instances the names and localities given by Mr. C. W. Peach have been carefully copied, and his original labels preserved. As there are numerous duplicates among these fossils, I trust that the Society will empower me to make exchanges with dealers, collectors, or other Museums. In this manner our Fossil collection might be increased with little or no expense, and our duplicates would be doing good in other districts, instead of being hidden away in drawers.

I am pleased to say that the Society has received seventy-two donations, comprising upwards of a hundred specimens of rocks, minerals, and fossils, a full list of which is appended to my report.

Among these I may notice particularly rich Micaceous Iron Ore from North Molton, curious reniform Iron Pyrites from East Pool Mine, beautiful Uranium Ochre from St. Just, fine Rutile from Norway, massive Magnetite from Haytor, plant-like impressions in shale from Bude, Calamine from the Laurium Mines, Greece, and Chalkosiderite from West Phœnix Mine.

In conclusion, I will call your attention to the purchases that I have made for the Society. In all, a sum of £10 has been expended, and specimens of no less than sixty minerals have been procured. Many of them are species that are entirely new to our Collection, whilst others have been purchased because they were more representative specimens, exhibited better crystals, or illustrated other modes of occurrence than what we had previously. Two-thirds of the specimens were obtained from the well-known Freiberg mineral dealer, Herr B. Wappler, who executed my commission to my entire satisfaction.

List of Donations to the Museum in the order in which they were received:

By Mr. M. G. Klingender—

Micaceous Iron, Bampfylde Mines, North Molton.

By Dr. C. Le Neve Foster—

Toadstone (2 specimens), Doveholes, Buxton.
Stone scratched by ice action, Moraine in Cwm Glas, Snowdon.
Felstone, Llyn Llydaw, Snowdon.
Felstone, Twll Du, Llanberis.
Slate, Twll Du, Llanberis.
Stratified Felspathic Ash, Lliwedd, Snowdon.
Felstone, Ridge South of Cwm Dyli, Snowdon.
Felstone, Pass of Llanberis, near Gorphwysfa.
Cleaved Felspathic Ash, Cwm Patric, Llanberis.
Felstone, Llechog, Llanberis.
Cleaved Felspathic Ash, Llechog, Llanberis.
Felstone, Top of Y Garn, Llanberis.
Felspathic Ash, Lliwedd, Snowdon.
Felstone, showing lines of flow, Llyn Llydaw, Snowdon

Felstone, Cwm Glas, Snowdon.
Domite, Puy de Dôme, France.
Diallage Rock, Penig, Saxony.
Micaceous Porphyry, Meissen, Saxony.
Bulimus ellipticus, Bembridge Limestone, Ryde, Isle of Wight.
Achatina costellata, Bembridge Limestone, Ryde, Isle of Wight.

By Captain JOHN HOSKING—
Iron Pyrites, East Pool Mine, Redruth.

By Captain JOHN BOYNS—
Uranium Ochre, Wheal Edward, St. Just.

By Mrs. MURPHY—
Uranium Ochre, Wheal Edward, St. Just.

By Mr. F. REDDICLIFFE—
Blende, Galena, Calc-spar, and Pearl-spar, Great Laxey Mine, Isle of Man.

By the Rev. WILLIAM ROGERS—
Contorted Clay-slate, Mawnan.

By Mr. THOMAS EUDY—
Graphite in Elvan, Tuckingmill.

By Dr. C. LE NEVE FOSTER—
Ozokerite, Boreslaw, near Drohobycz, Gallicia.
Native Sulphur, Giona Mine, near Girgenti, Sicily.
Actinolite, South Terras Mine, near Grampound Road.
Axinite, Ugborough Mine, Ugborough, Devon.
Polyphant Stone, Polyphant Farm, near Launceston.
Garnetiferous mica-schist, south side of the St. Gotthard Tunnel. Rock that was being driven through in August, 1874.
Phosphatic Nodule, Base of the Gault, near Farnham.
Orthoclase Crystals in Elvan, Tuckingmill.

By Messrs. MORGAN BROTHERS—
Graphite, Ceylon.

By Dr. C. LE NEVE FOSTER—
Stone polished by Blown Sand, Perranzabuloe.
Greisen, Zinnwald, Bohemia.

By Captain JOHN HOLMAN—
Lode of Cuprite, Malachite, and Copper Glance in decomposed Granite, South Caradon Mine, Liskeard.

By Mr. Thomas B. Provis—

Granite in Elvan, Parbola Mine, Gwinear.

By Dr. C. Le Neve Foster—

Two Specimens of Pseudomorphs of Schorl and Cassiterite after Orthoclase, Belowda Hill, Roche.

"Giant Granite," St. Dennis.

Native Gold in quartz, Port Phillip Mine, Victoria.

Orthoclase, Felspar Quarry at Helle, near Arendal, Norway.

Mica, Felspar Quarry at Helle, near Arendal.

"Fahlband," a Garnetiferous Mica-schist, with a little Iron Pyrites, the *congenial* enclosing rock (*country*) at the Kongsberg Silver Mine, Norway.

Hornblende, from an Apatite Vein, near Kragerö, Norway.

Rutile, Apatite Mine, near Kragerö, Norway.

Heulandite and Stilbite, Arendal.

Native Gold, with quartz and galena, Val Toppa Gold Mine, near Domodossola, Italy.

Quartz Porphyry, Zinnwald, Bohemia.

Pyromorphite, Wheatley Mine, Chester Co., Pennsylvania.

Cerussite, Wheatley Mine, Chester Co., Pennsylvania.

Inoceramus sulcatus, Gault, near Maidstone.

Analcime, Mörefjœr Iron Mine, near Arendal.

Scheelite, Val Toppa Gold Mine, near Domodossola.

Elaterite, Castleton, Derbyshire.

Rounded Stone (? Water-worn Pebble), found under the 147 fms. level, near the slide, at Wheal Metal.

Göthite, Watersmeet Mine, Lynton.

By Mr. William Linford—

Plant-like impressions in shale, Bude.

By Dr. C. Le Neve Foster—

Stream Tin, with a little Native Gold, The Ovens District, Victoria.

Magnetite, with a little Actinolite, Haytor Mine, Haytor, Devon.

Magnetite, interbedded with Actinolite Rock, Haytor Mine.

Magnetite, Chalcedony and Chalybite, Haytor Mine.

Magnetite, Actinolite Rock and part of an Intrusive Granite Vein, Haytor Mine.

Intrusive Granite Vein in Actinolite Rock and Siliceous Slate, Haytor Mine.

By Mrs. Williams—
Fossil Wood, Lyme Regis.
By Mr. A. K. Barnett—
Vein of Tinstone from Australia.
By Captain Simmons—
Chalkosiderite, West Phœnix Mine, Liskeard.
By Mr. A. P. Vivian—
Calamine, Laurium Mines, Greece.

LIST OF MINERALS PURCHASED FOR THE MUSEUM.

	NAME.	LOCALITY.
1.	Actinolite	Germany.
2.	Adularia and chlorite	Tavetsch, Grisons.
3.	Analcime	The Seisser Alp, Fassathal, Tyrol.
4.	Andalusite	Lisens, Tyrol.
5.	Anhydrite and Rock-salt	Berchtesgaden, Bavaria.
6.	Apophyllite	Andreasberg, The Hartz.
7.	Argentite with Chalybite	Freiberg, Saxony.
8.	Augite (eight crystals)	Boreslaw, near Teplitz, Bohemia.
9.	Bastite	Baste, The Hartz.
10.	Beryl	Monroe. U.S.A.
11.	Bismuthine	East Pool Mine, Redruth.
12.	Breithauptite & Chloanthite	Andreasberg, The Hartz.
13.	Brucite	Texas, Pennsylvania.
14.	Carpholite	Schlaggenwald, Bohemia.
15.	Chabasite on Phonolite	Rübendörfel, near Aussig, Bohemia.
16.	Chalcedony (two specimens)	Pednandrea Mine, Redruth.
17.	Chalybite	Carn Brea Mine, Redruth.
18.	Cobaltine (seven crystals)	Tunaberg, Sweden.
19.	Copper, Native	Lake Superior.
20.	Copper Glance	West Basset Mine, Redruth.
21.	Copper Nickel & Chloanthite	Sangerhausen, Thuringia.
22.	Copper pyrites	East Pool Mine, Redruth.
23.	Cuprite	Phœnix Mine, Liskeard.
24.	Desmine	Andreasberg, The Hartz.
25.	Dichroite with Titanic Iron and Quartz	Tvedestrand, Norway.
26.	Dillnite	Dilln, near Schemnitz, Hungary.
27.	Diopside (seven fragments of crystals)	Schwarzenstein, Zillerthal, Tyrol.
28.	Elæolite with Fluor Spar	Laurvig, Norway.
29.	Epidote	Unter Sulzbachthal, Tyrol.

30. Fluor Spar . . .	Carn Brea Mine, Redruth.
31. Gehlenite in Calc-spar .	Monzoni, Fassathal, Tyrol.
32. Hornblende . . .	Mückenhübel, near Aussig, Bohemia.
33. Hornblende (six separate crystals)	Lukow, near Teplitz, Bohemia.
34. Idocrase	Monzoni, Fassathal.
35. Iron Pyrites (eight crystals) .	West Basset Mine, Redruth.
36. Lead, Native . . .	Längsbanhytta, Sweden.
37. Ludgwigite and Magnetite .	Moravicza, in the Banat.
38. Millerite in Clay Ironstone .	South Wales.
39. Nacrite	Brand, near Freiberg.
40. Nagyagite (two specimens) .	Nagyag, Hungary.
41. Oligoclase	Arendal.
42. Olivine with Calc-spar .	Kaisertauern, in the Pinzgau.
43. Olivine in Basalt . .	Wohlbach, near Adorf, Saxony.
44. Prase	Breitenhof, near Schwarzenberg, Saxony.
45. Proustite on Chalybite .	Freiberg.
46. Pyrargyrite	Freiberg.
47. Quartz, red	Lancashire.
48. Quartz, pseudomorphous .	West Basset Mine, Redruth.
49. Scheelite on Quartz . .	Fürstenberg, near Schwarzenberg, Saxony.
50. Silver, Native . . .	Kongsberg, Norway.
51. Smithsonite . . .	Altenberg, Aix-la-Chapelle.
52. Spodumene and Quartz .	Island of Utö, Sweden.
53. Sylvanite	Offenbanya.
54. Topaz (thirty-three crystals)	Schneckenstein, near Auerbach, Saxony.
55. Triplite on Quartz . .	Schlaggenwald, Bohemia.
56. Uralite	Viazena, Fassathal, Tyrol.
57. Uranium Ochre . . .	Wheal Edward, St. Just.
58. Wulfenite	Bleiberg, Carinthia.
59. Zircon (two crystals) . .	Buncomb, North Carolina.
60. Zircon in Syenite . .	Fredriksvärn, Norway.

TREASURER'S STATEMENT, 1874–75.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

RECEIPTS.	£	s.	d.
To Balance	61	17	3
„ Donation H.R.H. The Prince of Wales	20	0	0
„ Trübner & Co. on Account of *Transactions* sold	6	3	1
„ Balance of Luncheon Subscription Fund	2	12	6
„ Ordinary Subscriptions and Arrears	80	17	0
„ Sale of Specimen to the British Museum	10	0	0
	£181	9	10

EXPENDITURE.	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper and Stores	3	18	0
„ Insurance	2	12	9
„ Expenses per Treasurer and Secretary	8	2	6
„ Advertising	1	18	9
„ Palæontographical Society	1	1	0
„ Printing, Binding, and Stationery	57	2	8
„ Sundry Bills	8	16	0
„ Grant in aid of Chemical Lectures to Mr. Barnett	5	0	0
„ Purchase of Minerals	10	0	0
„ Balance due to Society	82	10	2
	£181	9	10

W. BOLITHO, Jun.,

29th October, 1875. *Treasurer.*

LIST OF PAPERS READ AT ANNUAL MEETING,

OCTOBER 29th, 1875.

1. On a Diamond Field, Griqualand, South Africa. By Mr. Charles Fox.

2. On the Tin Deposits of East Wheal Lovell. By Dr. C. Le Neve Foster.

3. On a Deposit of Quartz Gravel, at Blue Pool, Crowan. By Mr. William Tyack.

4. Notes Concerning Fossils from Bude. By Mr. William Linford.

5. Remarks on Mineral Lodes. By Mr. James Williams.

A DIAMOND FIELD.

WEST GRIQUALAND, SOUTH AFRICA.

MY friend F. Baring Gould has given me the accompanying specimen of the matrix from which he and his brother extract diamonds in South Africa. The diamondiferous ground (of about six acres in that locality) does not diminish in value in depth (now 180 feet), and is most productive near the circumscribing rock, which is dark schist, having pyrites in its cleavage. There is a mass of this schist, and carbonate of iron and pyrites with diamonds, in one quarry. F. Baring Gould thinks that in their claims the average is one diamond in a barrow-load. There is no water in the bottom but that which comes from the sides. There is limestone in the neighbourhood as well as conglomerate rock resembling this specimen, but yielding no diamonds.

The matrix falls in pieces if water be poured on it when dry. Many diamonds split and crumble after being raised, especially if one angle is coloured. The accompanying garnets were intermixed. Chalcedony, garnets, carnelians, and jasper pebbles are found in a neighbouring river. Charred fragments of a tree (or trees) were found in different parts of the mass, 150 feet from the surface.

Each claim is thirty feet square; its sides are cut down smooth as a wall, lest a projecting piece no larger than a tea-cup should contain a Koh-i-noor.

C. Fox.

TREBAH, FALMOUTH,
November 10*th*, 1875.

Much information concerning the geology of the Diamond Fields of South Africa will be found in numerous papers published in the Quarterly Journal of the Geological Society of London. See papers by G. Gilfillan, Quart. Jour. Geol. Soc., vol. xxvii. p. 72; G. W. Stow, vol. xxviii. p. 3; Dr. John Shaw, vol. xxviii. p. 21; E. J. Dunn, vol. xxx. p. 54; Prof. Maskelyne and Dr. Flight, vol. xxx. p. 406; G. W. Stow, vol. xxx. p. 581.

REMARKS UPON

THE TIN DEPOSITS OF EAST WHEAL LOVELL.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

It may seem strange to some persons that I should have chosen for the subject of a communication to this Society a mine which is apparently so well known as East Wheal Lovell. Many mine agents will exclaim: "What is there to say about East Wheal Lovell that we do not know already?" It is true that East Wheal Lovell has been inspected by hundreds of agents; but they simply confined themselves to their immediate duty, *i.e.* valuing the lode as it stood, and reporting to their employers on the prospects of the mine. The consequence is that, as far as I am aware, there is no published account of a remarkable deposit of tin, the peculiarities of which struck me very forcibly when I visited the mine in the spring of last year.

With the kind permission of the purser, Mr. Henry Rogers, and thanks to the valuable assistance of Capt. Quentrall, his son, and Capt. Peters, I have been enabled to draw up a short account of some tin deposits, which I think will prove interesting to members of this Society.

East Wheal Lovell is situated in the parish of Wendron; the sett includes two mines, Tregonebris and Fatwork, both of which lie close to the turnpike-road leading from Penryn to Helston, and are about four miles from the latter town. It is my intention to-day to confine my remarks to the Fatwork portion, whence the principal riches of the mine have been derived.

On inspecting the plan of Fatwork mine, we find that two lodes have been wrought, called respectively the North Lode and the South Lode.

The accompanying sketch-plan (fig. 1, plate i.) shows by A B and A C D the bearings of the two lodes at the 40-fathoms level. The south lode is seen to bend to the west and join the north lode; the part A E shows the general bearing, from the 40-fathoms level to the 110 of the two lodes now united, and the *underlie* of which is nearly *nil* (or *dip* nearly vertical).

These lodes are usually very narrow, sometimes a mere joint or line of division in the rock, but occasionally a couple of inches thick; they consist of quartz, a little clay, and red oxide of iron, and *per se* are utterly valueless. In some places, however, you get curious deposits of tin on both sides of the vein, occupying very little space, but extremely rich.

As a type of these deposits, I will briefly describe what I saw at the 100-fathoms level about eighteen months ago.

Fig. 2, plate i., shows a plan of the deposit. A B is the *leader*, *divider*, or little vein of quartz and ferruginous

clay, from ¼ to ½-inch thick.* The dotted portion is the tinstuff, outside which we have the ordinary granite. The granite is well marked, with large crystals of orthoclase; the tinny portion consists of a mixture of quartz, mica, gilbertite, and cassiterite (tin-stone), with some fluor spar, iron pyrites, copper pyrites, bornite, copper glance, and chalybite. Gilbertite is often abundant. There is no *wall* or *selvage* between the tinny mass and the granite; the two fade away one into the other, and following the leader along the strike, you see the tinny rock decrease in width, until at last the vein has two walls of granite. The shoot of tin at the 100-fathoms level was much longer than usual; there was tin for about seven fathoms in all. The rich part, however, was fully three fathoms long, and eight or nine feet wide.

At the higher levels the shoot was often only 12 feet long by 12 feet wide, as shown in the fig. 3, plate i.; but there were always these constant characters; viz., the *leader* of quartz, the absence of any *wall* between the tin and the granite, and the same general composition—quartz, mica, gilbertite, cassiterite, &c. Very often the tinny portion was not so regular as shown above, but lay entirely on one wall, or more on one wall than the other. (Figs. 4 and 5, plate ii.)

The main shoot of East Wheal Lovell has been followed down from the 40-fathoms level to the 110 as one continuous *pipe;* and as one climbs up and

* The thickness in the figures is exaggerated.

down the shaft, which is merely the space left by the removal of the tinny mass, one feels how thoroughly the words *pipe* or *chimney* describe deposits of this kind. On looking at the section (fig. 6[a], plate ii.), it will be seen that the shoot is sometimes almost vertical, sometimes inclining a good deal in a south-south-westerly direction. To sum up, it may be said that this shoot is in the shape of a long irregular cylindroid, or cylinder with an elliptical base, generally about 12 to 15 feet long by seven feet wide. From the 40-fathoms level to the 50, this one shoot produced about two tons of clean tin-ore per fathom of ground sunk; from the 50 to the 90-fathoms level, about one ton per fathom; from the 90 to the 100, four or five tons of tin-ore per fathom sunk, taking the whole length excavated, varying from six to eighteen feet.

The section to which I have just referred shows other *pipes* and *bunches* of tin. As I did not see these while they were being wrought, I cannot give so many details concerning them; but I am informed by Capt. Quentrall that they closely resembled the *pipe* that I have just described; *i. e.* there was always a vein of quartz, with more or less tinny stuff on each side of it, which passed gradually into granite, free from tin. Capt. Quentrall also tells me, that on the north-eastern bunch, shown on the section, from about two fathoms below the 70 to seven fathoms below the 80, the whole of the tin-ground produced on an average four tons of tin per fathom (6 ft. × 6 ft.) for the width of the deposit (four to ten feet), often yielding from six to seven tons per fathom.

Taking the entire length (12 feet) of the shaft *a b*, the lode was estimated to be worth from £800 to £1,000 per fathom sunk (the *black tin* selling for about £80 per ton), whilst the sinking only cost about £40 per fathom. The little pipe from the 26 to the 41-fathoms level was very small—not more than five or six feet long by three or four feet wide.

A horizontal section at the 80-fathoms level (fig. 7, plate iii.), together with the longitudinal sections, will probably explain the deposits better than verbal description.

The East Wheal Lovell *pipes* and *bunches* resemble in their mode of occurrence some of the *carbonas* of the St. Ives district; but they differ by the absence of tourmaline, which is so very abundant at St. Ives.

Having described the manner in which the tin occurs, I desire to say a few words in conclusion on the mode in which it may have been deposited.

The *leader*, or *divider*, was evidently originally an open fissure, which was subsequently filled with quartz; but the tin-ore, on the contrary, bears no evidence of having been deposited in a large open cavity; in fact, all the appearances point the other way. To my mind it seems probable that, after the solidification of the granite, cracks were formed in it, through which vapours or solutions ascended that attacked and decomposed it more or less thoroughly. Parts of its decomposed constituents were carried off; other minerals, such as tin-stone, were deposited in their place from the vapours or solutions that filled the crack, and found their way into the walls; and

new minerals were formed out of the elements contained in the constituents of the granite and the newly-arrived substances. The difficulty that at once presents itself is this:—If the original crack or fissure was filled with these vapours or solutions capable of decomposing granite and depositing tin-stone, why do we not invariably find tin on both sides of the leader? Why is it confined to a few places where the deposition of tin-stone has extended only for a few feet, or at most a few fathoms, along the course of the original fissure? To overcome this objection, we must suppose that the vapours or solutions were in many cases forced into certain channels, and ascended through these only. It is very easy to imagine how such channels might be formed.*

Suppose that a vertical or inclined crack took place along a broken line A B C D E F G H. (Fig. 8, plate iv.) If one side is shifted a little *along the strike*, we get a succession of open gaps with intermediate parts, where the two walls of the fissure are closely in contact. (Fig. 9, plate iv.)

Now these gaps or openings, even if very narrow, might serve as chimneys to Nature's laboratory, and convey up stanniferous and other emanations from the bosom of the earth; their granite walls would be decomposed, gilbertite formed out of the orthoclase, and tin-stone and other minerals deposited. Between the shoots of tin we should have barren spaces where

* The best way of showing the formation of these channels is to take a block of wood, and have it sawn across irregularly, as shown in the figure.

the two walls were in contact, or separated merely by a layer of clay, produced by their attrition, and where the vapours or solutions could not easily penetrate. Finally the open gaps were filled with quartz, probably deposited from an aqueous solution; perhaps before this took place the fissure may have been opened a little.

If the fissuring and shifting had been as regular as that shown in figures 8 and 9, plate iv., we should have had nothing but long *pipes*. A glance at the section (fig. 6[a], plate ii.) shows, however, considerable irregularities in the shape of several pipes and bunches. This might be expected from the shifting of an irregular fissure, both along the dip and along the strike, forming irregular channels for the ascent of the stanniferous emanations.

It is not necessary here to discuss the question whether it is possible for granite to become altered into the curious mixture of minerals which we find in the East Lovell deposit,* nor to point out the exact processes by which the changes were effected. These are matters which have been already treated

---

* To prevent confusion, I have, as a rule, avoided applying the term *lode* to the East Lovell tin deposits; for scientists and practical miners are apt to use the word with different meanings. In books we often read that a lode is a fissure that has been filled up more or less completely by ores, with or without earthy minerals; miners will say that all the stuff from which they can extract ores forms part of the lode. Now, in the present instance, the stuff stamped and dressed is, in my opinion, the altered sides of a fissure, and not the filling-up itself; in other words, I suppose that the fissure served simply as a channel for conveying the tin-ore, and not as the place where it was deposited.

in a most able manner, and I must refer those who are desirous of information concerning the mode of formation of tin deposits, to the standard memoirs by Daubrée,* von Cotta's † account of the Altenberg

---

* Mémoire sur le gisement, la constitution et l'origine des amas de minerai d'étain. *Annales des Mines*, 3e série, tome xx., 1841, p. 65. Report on the above Memoir by Berthier, Elie de Beaumont, and Dufrénoy. *Comptes rendus de l'Académie des Sciences*, tome xiii., 1841, p. 854.

In the above memoir Daubrée describes the mode of occurrence of tin-ore in certain *stockworks* in Saxony, Bohemia, Cornwall, and France. He shows that, after quartz, the minerals most frequently accompanying tin-ore are compounds containing fluorine, principally fluosilicates (lepidolite, topaz), sometimes fluophosphates (apatite) and fluorides (fluor spar). The element boron (tourmaline, axinite) is often abundant. The other elements most commonly met with are tungsten, molybdenum, phosphorus, arsenic, and iron. Daubrée draws the conclusion that the tin-ore, fluorine compounds, and borosilicates owe their origin to the same set of reactions. He supposes that the tin, tungsten, molybdenum, boron, phosphorus, and some of the silicon came up through fissures from some deep-seated source as fluorides. Finally, Daubrée suggests that the present condition of the *stockworks*, which consist of quartz, tin-ore, silicates, fluosilicates, and borosilicates, resulted from the reactions of these fluorides, probably in the presence of water, on the enclosing rocks.

Recherches sur la production artificielle de quelques espèces minérales cristallines particulièrement de l'oxyde d'étain, de l'oxyde de titane et du quartz. Observations sur l'origine des filons titanifères des Alpes. *Annales des Mines*, 4e série, tome xvi., 1849, p. 129. *Comptes rendus de l'Académie des Sciences*, tome xxix., 1849, p. 227. *Comptes rendus de l'Académie des Sciences*, tome xxx., 1850, p. 383.

The first part of this memoir gives the results of experiments made by Daubrée, with a view of imitating the processes by which nature may have acted in forming minerals. Instead of using fluorides, which are not so easily prepared, Daubrée generally employed chlorides. From the great analogy of fluorides with chlorides, he considers that results obtained with the latter may be safely supposed to occur with the former.

The first experiment consisted in passing a current of stannic chloride

Zwittergestein, and the capital essay by my old friend Prof. A. Stelzner,‡ on the Granite and Tin deposits of Geyer. My principal object has been to record some interesting and useful facts concerning a well-known mine, whilst it was only a secondary consideration to offer an hypothesis as to the manner in which these unusually rich and curious deposits were formed.

The accompanying tabular statement of accounts, kindly furnished to me by Mr. Rogers, and produced

---

and a current of steam into a red-hot porcelain tube. Double decomposition took place, and crystals of stannic oxide were deposited on the sides of the tube. The crystals were found to belong to the rhombic system, which shows that stannic oxide, like titanic oxide, is dimorphous. The temperature of the end of the tube, where the crystals were deposited, did not exceed 572° F (300° C), or, in other words, was rather less than the melting point of lead. Titanic chloride, treated in the same way, gave crystals of brookite; whilst a deposit of vitreous and in part crystallized quartz was obtained from chloride of silicon and steam.

Expériences sur la production artificielle de l'apatite, de la topaze et de quelques autres minéraux fluorifères. *Annales des Mines*, 4e série, tome xix., 1851, p. 684.

Daubrée obtained well-crystallized apatite by passing perchloride of phosphorus over lime at a dull red heat; when passed over white-hot silica, the same compound gave chloride of silicon. Artificial topazes were made by Daubrée by the action of a current of fluoride of silicon on alumina at a white heat.

† Festschrift zum hundertjährigen Jubiläum der Königl. Sächs. Bergakademie zu Freiberg, p. 156. Dresden. 1866.

Prof. von Cotta proves that there is a gradual passage from fine-grained reddish granite to the almost compact black stanniferous *Zwittergestein*. The *Zwittergestein* is an altered granite which has lost about 3 per cent. of silica and 2 per cent of potash, and has taken up 4 per cent of ferrous oxide, and ½ per cent. of stannic oxide.

‡ Die Granite von Geyer und Ehrenfriedersdorf sowie die Zinnerzlagerstätten von Geyer. Von A. W. Stelzner. Freiberg. 1865.

to the adventurers at their meetings, held from October 1869 to May 1871, shows the extraordinary result of a net profit of £27,000, on sales of tin amounting only to £38,000; in other words, the dividends declared amounted to about 70 per cent. of the value of the tin sold.

EAST LOVELL.—STATEMENT OF COST AND DIVIDENDS

From 1st October, 1869, to 26th May, 1871.

MEETING.	COST.			DUES.			BLACK TIN.				VALUE OF TIN.			DIVIDEND.		
1869.	£	s.	d.	£	s.	d.	tons	cwt.	qrs.	lbs.	£	s.	d.	£	s.	d.
October 1 .	1014	8	7	324	13	0	75	8	3	24	5922	17	3	3812	0	0
Decr. 31 .	1663	8	6	310	10	2	77	7	2	1	5749	19	5	3812	0	0
1870.																
April 7 .	1189	8	9	296	14	3	73	2	1	2	5408	6	2	3812	0	0
July 4 .	1026	4	3	277	5	6	59	19	1	2	5109	16	3	3812	0	0
Nov. 16 .	1110	5	3	293	14	4	71	7	3	7	5417	9	10	3812	0	0
1871.																
Feb. 27 .	1809	6	10	313	10	1	70	7	0	17	5781	0	0	3812	0	0
May 26 .	1174	11	2	291	14	4	66	10	2	2	5288	5	1	3812	0	0
Total . .	8987	13	4	2108	1	8	494	3	1	27	38677	14	0	26684	0	0
Dues . .	2108	1	8	.....			.....		.....		11095	15	0	.....		
Total Cost .	11095	15	0	.....			.....		Profit .		27581	19	0	.....		

Fig. 1.

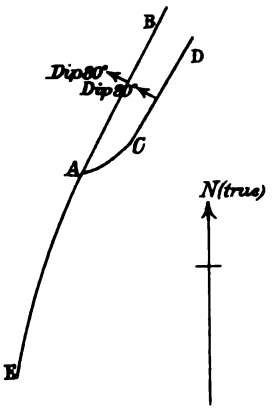


Fig. 2. Plan.

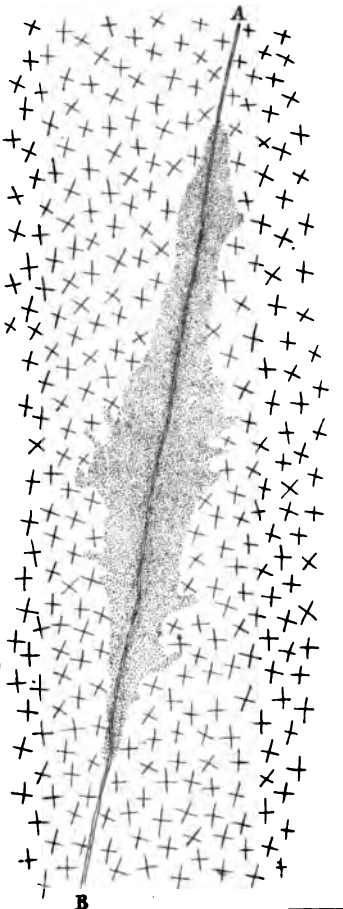
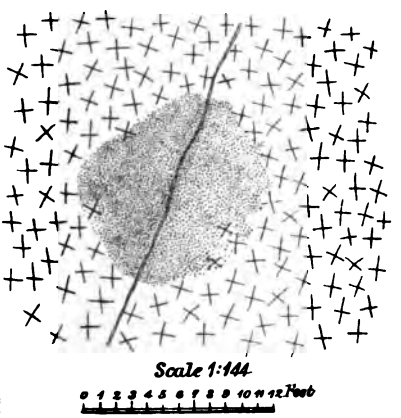


Fig. 3. Plan.



Granite

Rock impregnated with Tin Ore

Scale 1:144

Feet 6 5 4 3 2 1 0 1 2 3 Fathoms

Fig. 4.

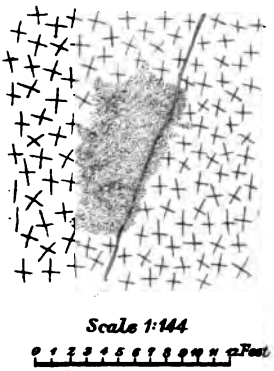


Fig. 6a.

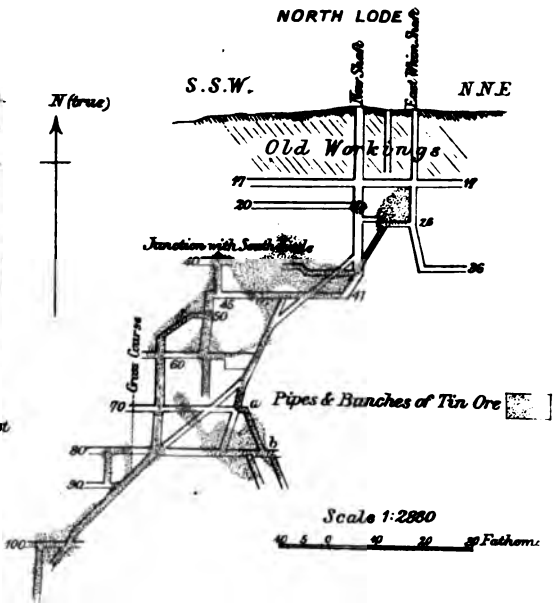


Fig. 5.

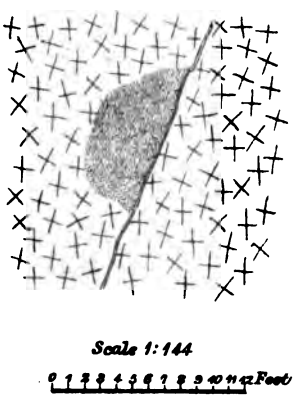
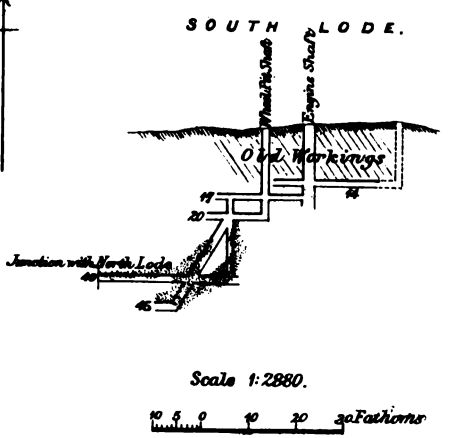


Fig. 6b.



Rock impregnated with Tin Ore.

Granite

Fig. 7. Plan.

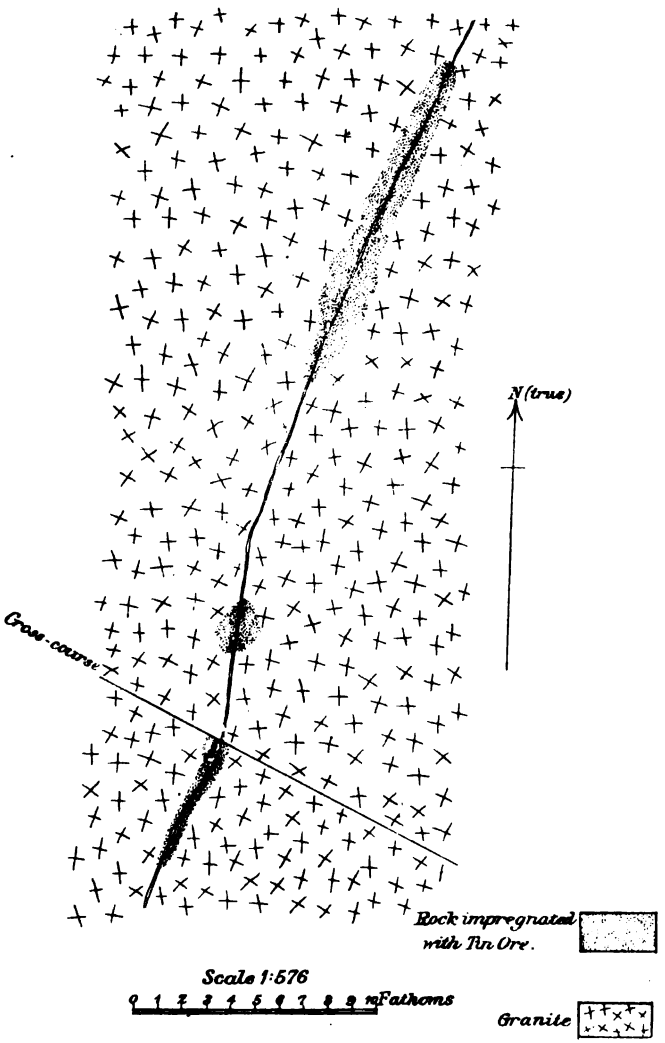

N (true)
Cross-course
Rock impregnated with Tin Ore.
Scale 1:576
0 1 2 3 4 5 6 7 8 9 10 Fathoms
Granite

Fig. 7. Plan.

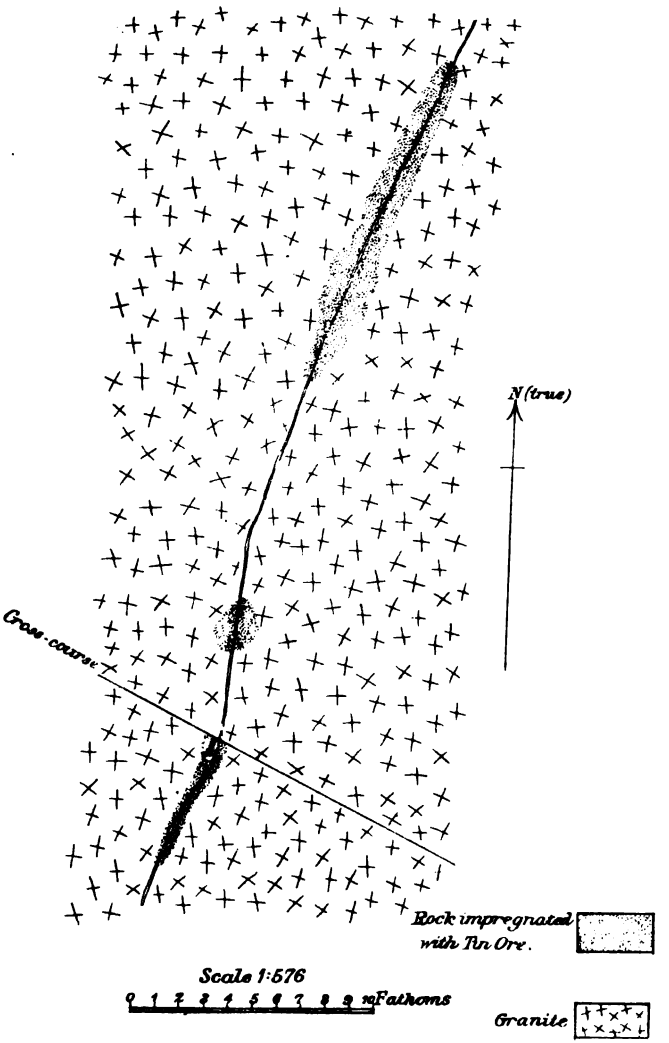

N (true)
Cross-course
Rock impregnated with Tin Ore.
Scale 1:576
0 1 2 3 4 5 6 7 8 9 10 Fathoms
Granite

Fig. 8.

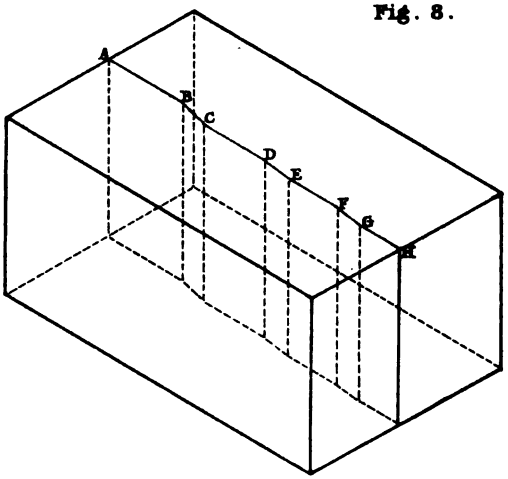
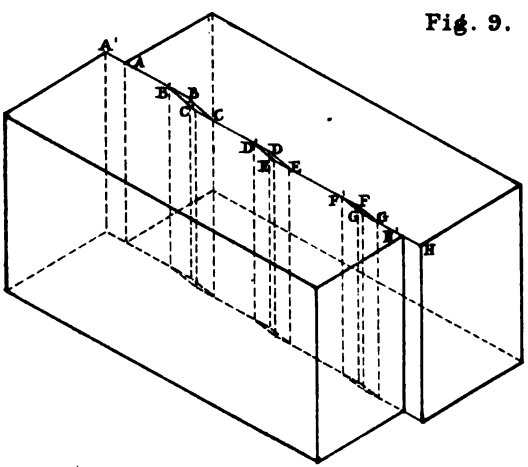


Fig. 9.



ON A DEPOSIT OF

QUARTZ GRAVEL AT BLUE POOL, IN CROWAN.

By Mr. William Tyack.

(Communicated by Dr. C. Le Neve Foster.)

On an elevated piece of unenclosed land or common near Polcrebo, in the parish of Crowan, and locally known as the Blue Pool, is a phenomenon of some geological interest, as it strikingly illustrates the changes which have taken place in the surface configuration of the earth. It consists of an accumulation or deposit of quartz pebbles in a purely granite district.

The pebbles are of quartz, varying in structure and colour, very similar in appearance to the angular and subangular stones commonly called *spar*, so frequently to be met with in the clay-slate (*killas*) districts of West Cornwall. At first sight they look like sea-beach pebbles; but on closer inspection and comparison with beach pebbles from the Loe Bar and Perranuthnoe, they appear to be somewhat less smooth, and to have been subjected to less attrition; and when compared with the pebbles from the Cober river at St. John's Bridge, they show evidence of being considerably more water-worn and rounded. They are of all sizes, from boulders as large as a

pumpkin to pebbles as small as hazel-nuts; the larger ones are few in number, and generally found most deeply bedded in the soft clay on which the greater part of the pebbles lie; they are also the smoothest. The small ones are most numerous, and are generally on, or very near, the surface. Most of the pebbles are about the size of a hen's egg; the very small ones are but slightly more water-worn than those of any river-bed pebbles in the district.

They lie on a gentle slope at the head of a small valley, drained by a tributary of the river Cober, and not more than half a mile from the watershed between the north and south coast. The little valley is entirely in granite, and the pebbles lie at the head of two rivulets, which rise one at either end of the deposit; they come together about 1,500 yards to the east, and fall into the Cober at Trenear, in Wendron. The pebbles lie about 150 feet lower than the lowest part of the watershed to the west of them, which separates the basin of the Cober from that of the Hayle river.

The area covered by these pebbles is about 800 yards from north to south, and 500 from east to west; the valley below runs from N.W. to S.E., between two ranges of granite hills. The pebbles are thickest in or near the central part, and they gradually thin off towards the outer limits. They lie in large quantities on the surface, and amidst the few inches of black earth which forms the soil, on which a little heath and stunted Cornish furze struggle for existence. Beneath the surface earth, there is a subsoil several

feet deep, consisting of a yellow clay,* with small fragments of angular quartz and mica, the result of decomposed granite, such as are to be found in many of the granite moorlands of Cornwall. Some of the larger pebbles are bedded at various depths in the subsoil, which is soft, and during the winter months very wet. In many places pits from two to eight feet deep are open, and some of the smoother and larger pebbles are found as deep as the bottom of these pits. The pits were made by the tin-streamers, and the gravel has been worked for tin within the memory of persons now living in the neighbourhood; but it was never very rich; and the streaming had to be carried on at great disadvantage, on account of the scarcity of water. Rain-water was the only means by which the stuff could be dressed, and large ponds or pools were made to catch the surface-water during the winter months, and store up a supply for the summer use. It is possible that the name Blue Pool was given to the place on account of these ponds. The gravel was sometimes carted away to other places to be stamped and dressed. In the valley below, about a mile from the deposit, at an old abandoned stream-work on the course of the stream, at Velanhausen, are to be found pebbles similar to those at Blue Pool, mixed with the refuse from the stream-works, and locally known as *Killyer Banks;* but whether they were carted there or brought by water down the valley is not easy to say.

* There is china clay to the west, within two hundred yards, which appears of a fair average colour.

The Blue Pool gravel lies at an elevation of about 400 feet above the sea level, and the neighbouring granite hills rise at least 100 feet higher; all the river-water now near them is flowing away from them. The pebbles appear to have been brought by river-water to their present position from some clay-slate district, and deposited at the bottom or side of a river or freshwater lake. The nearest places where a quartz similar to that of the pebbles occurs are Nancegollan and Sithney Downs, about a mile and a half to the south-west, and about 200 feet below the intervening granite hills of Maen-ambar. At Helston Downs and Boskenwyn Downs, in Wendron, near Gweek, about four or five miles to the south-east, there is also quartz, which, if water-worn and rounded, would present an appearance similar to the pebbles at Blue Pool. One thing is very evident, the pebbles have been subjected to considerable attrition by the action of water; and if brought to their present position by river-water, the surface of the entire district must have undergone some very considerable change or changes, as there is not the remotest apparent chance or possibility of their being placed in their present position by any of the agencies or forces now at work with the present surface configuration of the district. Besides, the gravel, probably derived from a *killas* district, lies at a greater elevation than any clay-slate anywhere near it. This of itself proves a vast amount of denudation; for the valley down which the pebbles were rolled has been entirely obliterated. It would also

seem, from the extent of the deposit, much of which is being constantly removed for road metal, that the river which deposited it must have been much larger than any in West Cornwall at the present time.

It is somewhat remarkable that there are no well-worn granite pebbles mixed with the quartz; but the few granite stones about or mixed with them are rough and angular. Some of the pebbles have a crystalline structure, like the quartz forming the sparry cross-courses which traverse the clay-slate districts. And there are also a few pebbles of schorl rock, or schorl and quartz. These latter rocks are often found near the junction of granite and clay-slate. The clay on which the gravel lies is probably due to the decomposition of the underlying granite.

In conclusion, I may mention that there is a gravel, somewhat similar to the Crowan deposit, at Crousa Downs, in St. Keverne.* It consists of water-worn quartz pebbles, and lies on Diallage rock. The best section is seen at Trevivian gravel-pit, about three furlongs E.N.E. of the stones, known as the Brothers of Grugith, whence considerable quantities of gravel have been obtained, as the deposit is here at least fifteen feet thick. It does not lie at so great an altitude as the Blue Pool gravel. The specimens sent to the Museum will give an idea of the size and character of pebbles as they are found.

---

* *Report on the Geology of Cornwall, Devon, and West Somerset.* By H. T. De la Beche, p. 395.

NOTES ON SOME FOSSILS FOUND AT BUDE.

By William Linford, Esq.

The fossils which I have sent to the Museum consist chiefly of plant impressions, collected in the summer of 1874, near the northern side of Bude Haven.

Especial attention is directed to the following: Firstly. The fossil fruits, &c. The larger ones were found *in situ* in a bed of shale, about fifteen or sixteen feet thick. Many much larger ones than these were embedded there, some of which had the outer part broken, leaving the centre exposed. This consisted of *soft black* matter, very *smooth* to the touch, as in the broken one included with those now sent.

The smaller ones were taken from a large block of shale lying on the beach close to the cliff; and from its fresh, unweathered appearance had probably been very recently broken off rocks above.

Secondly. The small fragment of shale, with a fern pinnule on one side, and on the other the tip of a leaf.

Thirdly. Water-worn fragment of shale, picked up on the sands very near all the others. It has circular and oval cavities, some with a raised centre, others hollowed, but both having radiating markings, some from the centre.

It is a question whether these are impressions of leaf or seed-pod, or are due to fracture.

Fourthly. Shale, with lepidodendron. This was found *on the Down*, not *in situ*, on the same side of the harbour as the others.

Fifthly. Curved fragments taken from blocks of stone; bark of endogenous trees. (*Qy.*)

I have also sent some drawings,* as follows:

A and B. Figures of blocks of building-stone—outer surface smooth—some resembling the curved fragments (No. 5), others with pyriform, circular, and other proturberances. Many such blocks were to be seen in the heap from which these were selected merely as typical specimens. It will be observed that these are arboriform, probably forming parts of trees.

C. Figures of fossils in blocks that had been split, laying open these fossils to view.

D. Figure of large block, with various protuberances, &c. of rock, from which blocks of sandstone had been removed, leaving hollows in the smooth shale.

Near the northern point of the haven was a portion of the cliff, from which blocks of stone had been removed, leaving hollows as above. The smooth shale was about four feet and a half wide. Blocks, with convex ends, were then resting on it.

---

* These drawings have been deposited in the Society's rooms.

ABSTRACT OF A NOTICE ON MINERAL LODES.

By Mr. James Williams, of Hayle.

In this communication, the chief object of the author was to point out the importance of paying attention to the junction of lodes, especially of the regular east and west lodes, with the caunters; and to suggest that large sums of money would be saved by ceasing to drive at long distances from such junctions.

QL
666
C8
A2
v. 9
pt. 3

TRANSACTIONS

OF THE

Royal Geological Society

OF

CORNWALL.

INSTITUTED FEBRUARY 11th, 1814.

VOLUME THE NINTH—PART THE THIRD.

"A knowledge of our subterranean wealth would be the means of furnishing greater opulence to the country than the acquisition of the mines of Mexico and Peru."

President of the Board of Agriculture.

PENZANCE:
SOLD AT THE APARTMENTS OF THE SOCIETY.
1877.

UNIVERSITY OF MICHIGAN

ON THE OCCURRENCE OF TIN IN AN ELVAN COURSE AT WHEAL JENNINGS.

By George Seymour, Jun.,
Associate of the Royal School of Mines.

This mine, formerly known as Parbola, is situated in the parish of Gwinear, about a mile to the south of the Gwinear Road Railway Station. The "country" is the ordinary bluish-gray killas of the locality, generally dipping south at an angle of about 50°. There are no indications of a lode occurring near the elvan in this sett, which is traversed from east to west by a powerful elvan course, the occurrence of tin ore in which presents some interesting features.

The general character of this deposit approximates somewhat to that of the German Stockwerke, consisting of an infinite number of small veins running through a non-stratified rock, the whole body of which is traversed by them. It differs, however, from true Stockwerke, inasmuch as the tin-bearing branches follow one direction. Such a deposit is however by no means without precedents in Cornwall; and the names of Castle-an-Dinas, at St. Columb, the Terras Mine, near Grampound Road, and the celebrated Wherry Mine, in Mount's Bay, may be quoted as occurrences of a similar nature.

Mr. Henwood, in his work on the Mineral Deposits of Cornwall and Devon, also devotes a few brief remarks to the instance described in the present paper.

The tin-bearing elvan course in question traverses the country in a generally east and west direction, passing through the South Rosewarne and Parbola setts, and running east to the Trevoole elvan quarries by the side of the Helston Road, where some fine stones of tin have been obtained from it. A little further east it joins the great Gernick elvan, which, after taking a slight turn to the north, runs into the granite near Cardenham; but no tin has, I believe, been found in it after its passage into the latter rock.

In the Wheal Jennings sett the elvan course actually bears about 10° N. of W. and S. of E., underlying S. about 2′ in a fathom, the angle of dip being pretty constant throughout the mine. The dyke varies in breadth from 70′ to 80′; and the tin ore is found distributed throughout the whole extent in more or less parallel strings or branches running across the elvan. The texture of the matrix is variable, consisting generally of a hard yellowish-white elvan, frequently coloured red by the presence of iron, and occasionally passing into an almost violet-grey. In some places again it is almost pure white, especially near the ten-fathom level east of Tregoning's shaft, where it is also soft and earthy, crumbling easily beneath the fingers, owing to the kaolinising of the felspar. The ground here, which has proved fairly productive, can be easily worked

away with a pick. In the lower levels the elvan is generally harder, requiring the more frequent use of powder; and a red or buff colour has invariably proved the most productive, while the tributers look on the softer ground as the most congenial.

East of the engine shaft the mass changes to a light blue colour, and has proved unproductive, such having invariably been the case throughout the mine wherever the colour of the elvan has passed from buff or red into blue. Some magnetic iron was, I believe, found here in veins traversing the elvan.

East of Blewitt's shaft, towards the eastern part of the sett, the elvan course narrows to a width of from 40′ to 50′, widening again as it goes eastwards, and is traversed by several "iron floors" and crossings. The tin-bearing branches here course east and west, parallel to the course of the elvan, and at right angles to their general bearing, making somewhat larger. Such "iron floors" or horizontal joints, filled with oxide of iron, occur frequently throughout the mine, and are looked upon as favourable indications.

It is noticeable that, although situated at a considerable distance (two miles) from the granite, fragments of this rock have been found enclosed in the elvan. Such an instance occurred within 2′ of the south wall, where a mass of granite about 6″ square was found embedded in the elvan, the planes of junction being more or less rectangular and sharply defined. The edges of the enclosing mass of elvan exhibit a very perfect columnar structure, although

a tendency to break into rhomboidal masses is more generally apparent.

In no place does the elvan present a porphyritic structure; small rounded aggregations of quartz, visible through the lens, and occasionally perceptible to the naked eye, are frequent, as well as small radiating masses of schorl, and small dendritic markings of manganese, occurring most often in the soft and whiter elvans.

We now approach the occurrence of the tin ore. Throughout the whole of the workings at Wheal Jennings the elvan is traversed by more or less parallel and vertical strings of tin ore, or cassiterite, crossing the mass at an average bearing of 20° E. of N. and S. of W. (true). (Plate i. fig. 1.) These strings consist almost entirely of cassiterite, frequently intermixed with a little quartz. When tested for boric acid before the blow-pipe with CaF_2 and $K.H.SO_4$ some of these strings give a very decided green flame, due probably to the presence of schorl, previously mentioned as frequently occurring in the body of the elvan. In only one instance has the presence of a minute quantity of mispickel or white mundic been observed. The almost total absence of this mineral, as well as that of the ordinary iron pyrites, or sulphur mundic, is most important, since it does away with the necessity of calcining the ore, which, after being separated from its elvany matrix, is at once available for the smelter.

The walls of these branches are, as a rule, sharp and well defined. Instances however occur where

Fig. I. Plan.

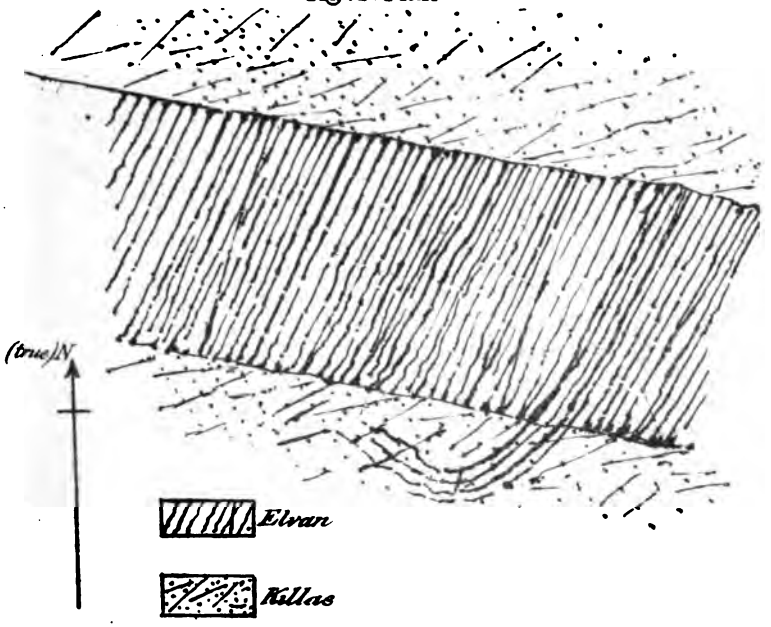


Fig. 2.

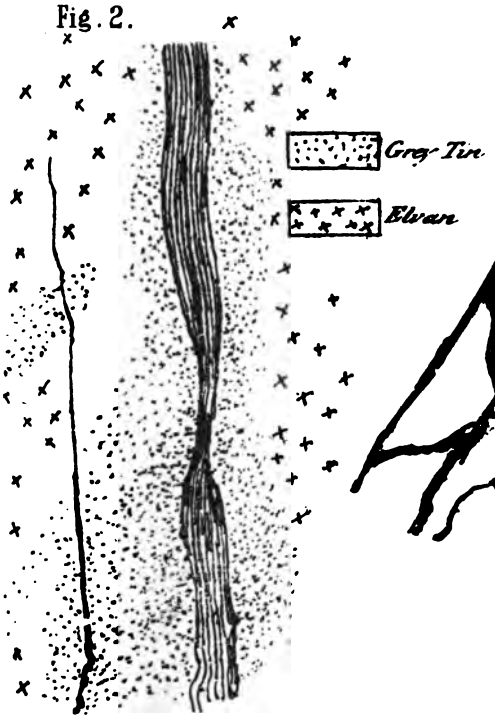


Fig. 3.

they pass more gradually into the texture of the mass, a small space on each side of the string being of a dark colour, owing to the elvan becoming impregnated with tin disseminated through it. These occurrences are known locally as "grey tin," and produce a considerable percentage of mineral. (Plate i. fig. 2.)

The bearing of these strings or branches across the elvan is uniformly regular. A slight inclination east or west is frequently observable, never however sufficiently pronounced or extended over a sufficient distance to constitute a decided dip in one definite direction, and as a rule they may be said to be as nearly vertical as possible.

The dimensions of these strings or branches also vary considerably. Some of them are no thicker than, and much resemble, a pencil line in appearance. As many as thirty of these strings can frequently be counted in the space of a single linear inch, whilst others again attain to as much as 4″, or even 8″ in thickness. The average breadth may be more generally stated at about $\frac{1}{16}$″. The most profitable branches are however those which run like masterly lodes for great distances, and are not unfrequently followed by tributers right across the dyke from killas to killas. Like lodes again, they are not unfrequently enriched by droppers falling into the hanging wall. Intersections are frequent both in strike and dip, although the general parallelism of the tin-producing planes is very apparent. In some places they interlace in all directions, forming a net-

work of tin-bearing strings. (Plate i. fig. 3.) The brown branches again generally prove richer than those of a black colour, and the tributers prefer a masterly brown branch, especially when making in softish ground, to any other.

In a stope 6′ wide under the 18 fm. level, E. of William's shaft, a great number of small parallel strings occur, making in a hard buff-covered elvan, averaging with great regularity about 16 to the linear inch, and varying from a pencil line to $\frac{1}{32}''$ in thickness. The elvan in this place is generally worth about 10 % for tin, but the best work, amounting last month to about $\frac{1}{16}$ of the stuff sent up, was worth, when tried, about 50 % for tin.

A little west of the engine-shaft a large, hard, and sparry cross-course, from 4′ to 5′ wide, runs across the elvan from north to south, and the branches in its immediate vicinity have, on the whole, made richer than in any other part of the mine.

It is observable, as before stated, that the most productive veins are those which pass across the elvan from killas to killas, other veins frequently falling into them. Where these, as well as the smaller veins, abut against the killas, they generally make against it in bunches, varying, according to the power of the vein, from the size of a pin's head to that of a man's fist. (Plate ii. fig. 1.)

Isolated instances have occurred of the tin veins penetrating beyond the walls of the elvan and making in the killas; and in the month of June last a group of veins was followed to a distance of a couple of

Fig. 1 Plan.

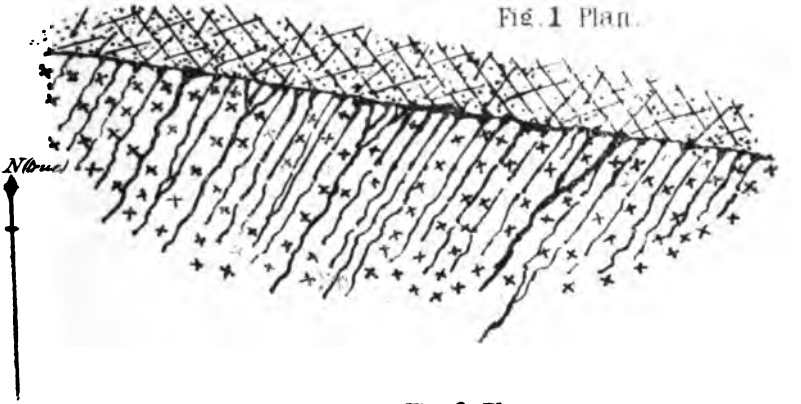


Fig. 2 Plan.

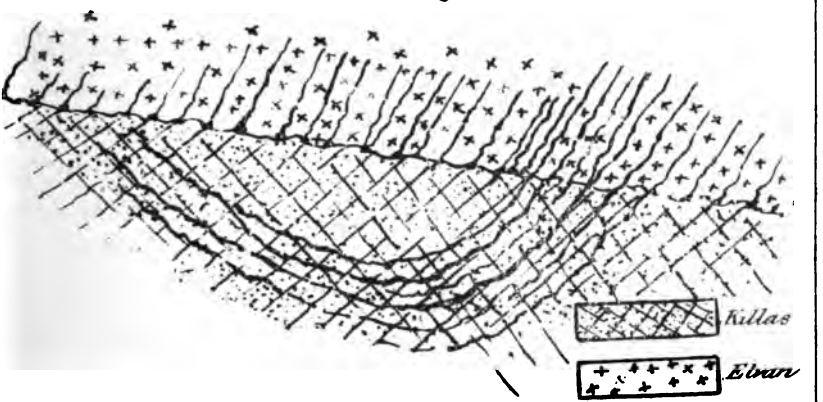


Fig. 3.

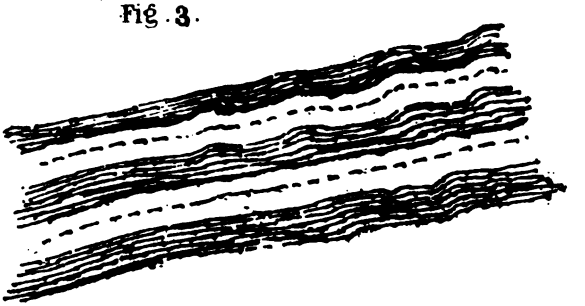


Fig. 5

fathoms, making a good bunch of tin in a hard quartzose schorlaceous killas. Such strings are plainly observable on the south wall of the elvan bearing into the killas about 15° S. of W. After proceeding for a short distance they generally turn and make back towards the elvan, as shown by the dotted lines. (Plate ii. fig. 2.)

A leader in this locality (stopes at back of ten fathom east of Tregoning's shaft) making from 3″ to 4″ wide, and generally averaging 5″ to 6″ in width, made in a bluish killas with peach and prian. Much of the killas on either side of the branch is impregnated with and worked away for tin disseminated through it (as in the case of the "grey tin" occurring in the elvan), of which it contains as much as 55 %. Some of the killas in this locality has blackish strings running through it, interstratified with white ones, and approaching a tourmaline schist, being a killas altered by the formation of schorl within it. (Plate ii. fig. 3.)

A noticeable peculiarity in Wheal Jennings is the occurrence, especially in the vicinity of the ten-fathom level, of horizontal heaves or throws, which tend to displace the vertical strings or branches from a given level south to a deeper level as they go north; or, to speak more correctly, the dislocated strings gain in depth as they oppose the dip of the elvan, descending as it were in steps or stairs, the highest step being nearest the south and the lowest nearest the north wall of the elvan.

A glance at the annexed diagram will best explain

this phenomenon. A series of strings start from the south wall of the elvan (Plate iii. fig. 1), whence they run in a more or less southerly direction (10° W. of S.) At *a* they are cut off by the more or less horizontal plane or slickenside, A. B. C. D., varying from 3′ to 5′ in width, throwing them north for this distance, beyond and below which the same strings again occur, extending north for a distance of from 3′ to 6′, when they once more disappear, cut off by a second horizontal plane, E. F. G. H., throwing them from 3′ to 5′ further; and the same branches can frequently be followed by similar successive steps from one wall of the elvan to the other.

The heaving planes in question are generally soft and smooth, except where striated by the movement over them of the vertical branches, whose edges have frequently scored their surfaces in the direction of the movement. That the displaced strings are really continuous throughout a whole series of dislocations is evident, since each branch invariably maintains the same relative position with respect to its fellows; and secondly, because traces of mineral are occasionally found in the striations mentioned as occurring on the horizontal planes, and this is especially noticeable in the track of the larger branches.

The dislocating planes are not invariably horizontal, and sometimes throw the strings in the reverse of the normal direction; *i.e.* from N. to S. When any doubt occurs the branches are found by following the miner's usual rule in such cases; *i.e.* driving on the side of the greater angle. (Plate ii. fig. 5.)

Fig. 1.

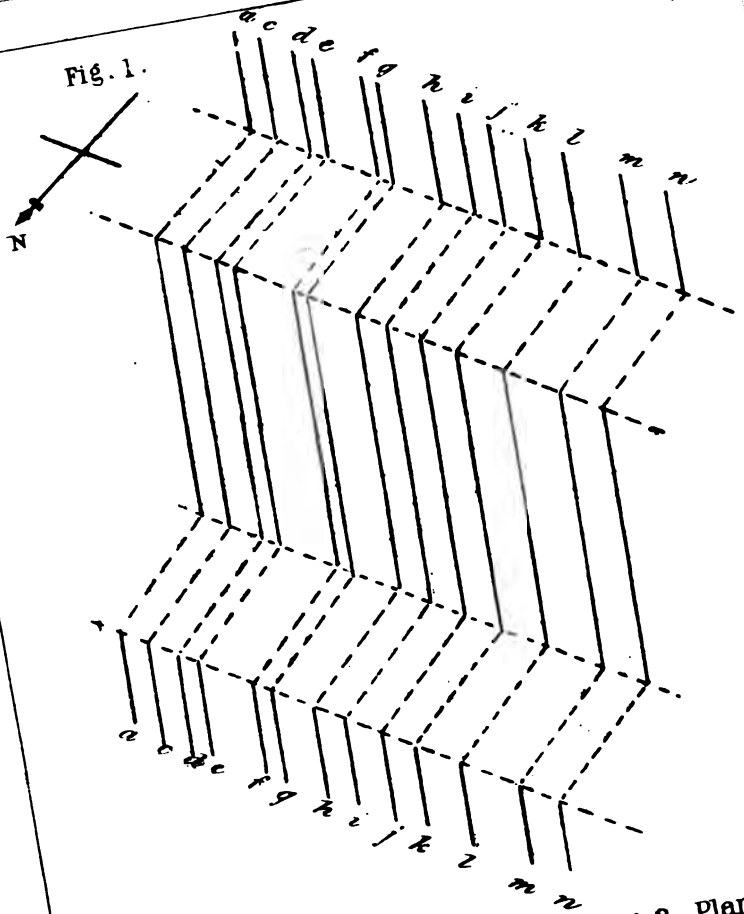
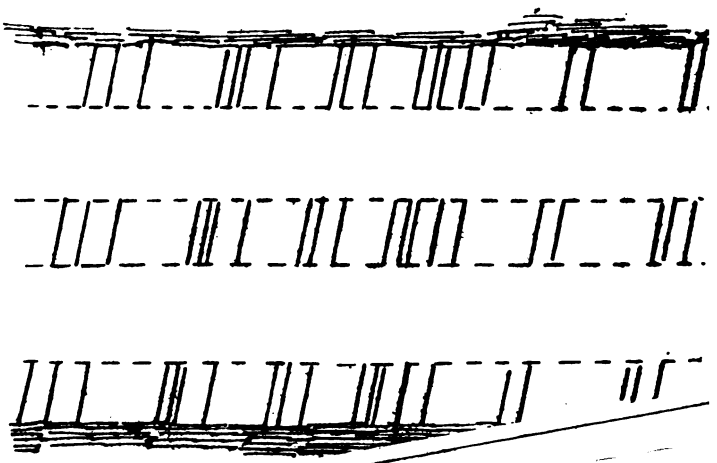


Fig. 2. Plan.



Having stated the most important geological phenomena noticeable in connection with the mine, I will now venture on a consideration of the geological conditions under which it appears probable that the deposit may have originated.

In the case of an ordinary lode the explanation would be a comparatively easy one, since the fissure itself would serve as a channel to convey up the gaseous emanations from the interior of the earth to crystallize out in such pre-existent fissures, cavities, or porous aggregations of matter in the partly formed lode, as could be easily filled and permeated by these vapours, the whole being subsequently still further consolidated by such cementing materials as quartz, calcite, fluor-spar, &c.

In the case referred to, however, the question assumes a somewhat more complicated form. Instead of finding the metalliferous substances distributed among the well-defined cementing materials of a lode, once an open fissure, we here find them crystallized out in a matrix, itself once unquestionably in a fused or pasty condition, and in some such state intruded from below. That the elvan itself served, through some fissures or openings in its mass, as a duct for the passage of the metalliferous substances now embedded in it is more than probable, and it only remains to account for those joints or fissures in which the tin ore is now found distributed throughout its mass. There can, I think, be but little doubt that the strings in question originated in shrinkage-fissures, due to the contraction of the mass during the process

of cooling, when the laminæ probably separated on the surfaces of weakest cohesion. Similar shrinkage-fissures are especially noticeable in the case of phonolite, a rock which bears a great petrographic resemblance to the elvanites or quartz-porphyries, and in which the character of the laminæ, notwithstanding the generally opposed conditions of cooling, would seem to be frequently identical with those which must have existed in such a case as that at present before us, previous to the intervening planes being filled in and cemented by the introduction and subsequent crystallization of the stanniferous vapours.

At some period then subsequent to the formation of these shrinkage-fissures through the cooling of the mass, and after a greater or less interval of time, it would appear that stanniferous emanations ascended through the more or less fissured body of the elvan in sufficient volumes to force their way into every small crevice and fissure now filled with tin, crystallizing of course with greater regularity in the larger branches, from many of which fine specimens of crystallized cassiterite have from time to time been obtained. Where the mass of the rock was in a greater degree porous, the emanations penetrated into and impregnated the adjacent elvan (as was more especially the case near the larger branches), thus forming the deposits of so-called "grey tin" previously referred to.

From the non-continuance of the tin-bearing strings across the dislocating planes, described when alluding to the step-like heaves occurring in the

elvan, it may be inferred that the disturbances which induced the throws in question took place subsequent to the filling up of the branches.

With reference to the granitic masses occurring in the elvan, I do not think it probable that they were brought up by it, as many suppose, from unknown depths. I would rather conjecture that the eruptive mass was forced up through the fissure it at present occupies in an ascending and generally *westerly* direction; in which case, at a less or greater depth, it would necessarily be forced between the granitic walls which confine it a few miles further east. The friction of the elvan against these is likely to have detached those portions now found imbedded in its mass, and their close proximity to the walls would appear to confirm this view. It is also worthy of notice that the granitic fragments are sharply angular, and in no degree worn or rounded.

In conclusion, I have to thank Capt. Rutter for much valuable information and ample facilities afforded me for examining this interesting mine. To Dr. Foster I am also indebted for much kind assistance.

ON

SOME BEDS OF SAND AND CLAY

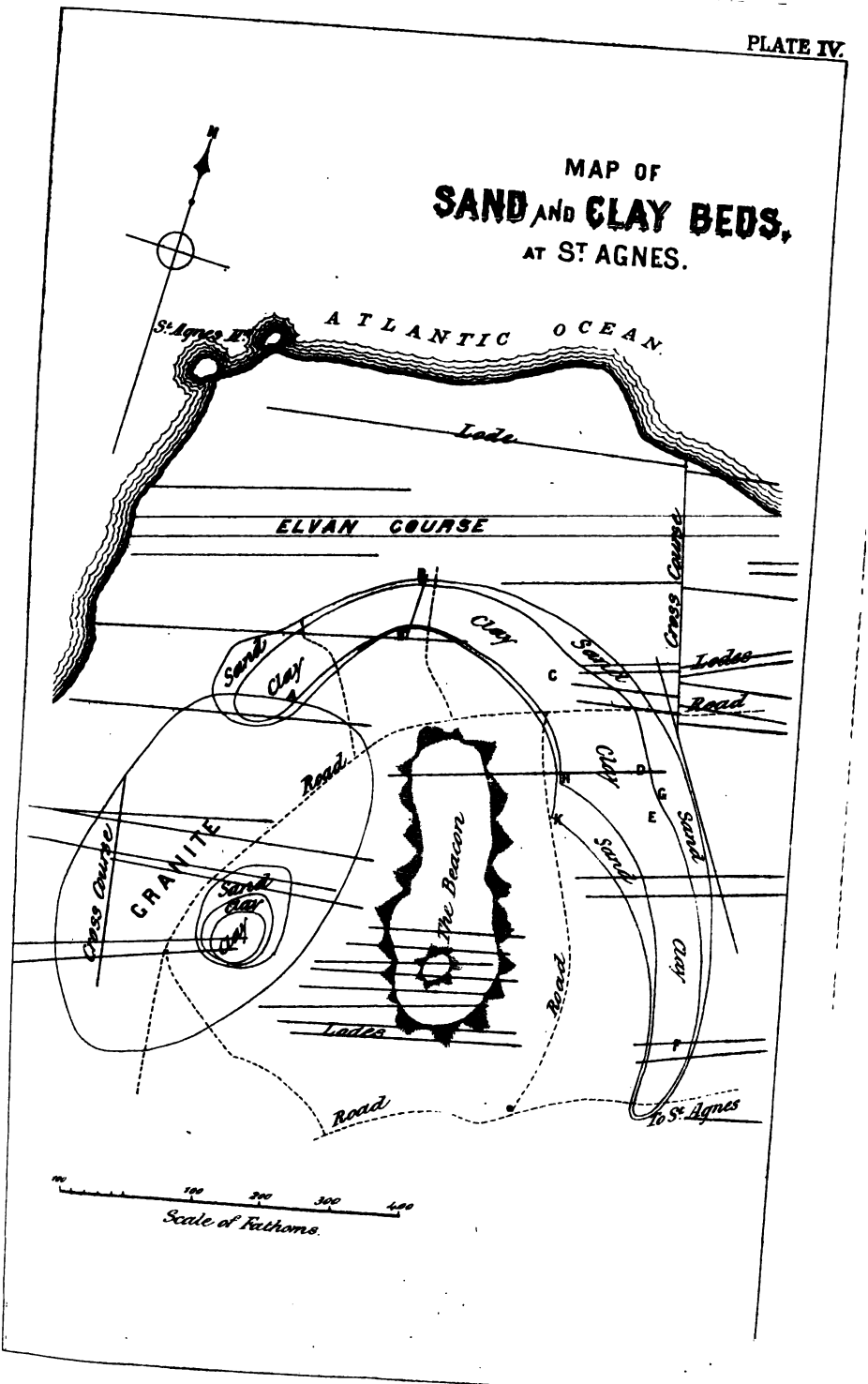
IN THE PARISH OF ST. AGNES, CORNWALL.

By Alfred T. Davies, and Benedict K. Kitto, F.G.S.

These deposits formed the subject of a paper read before this Society in October, 1830, by John Hawkins, Esq., F.R.S., and published in the fourth volume of the *Transactions*. In the same volume reference is made to these beds in Dr. Henry S. Boase's "Contributions towards a knowledge of the Geology of Cornwall." Sir Henry De la Beche also refers to them in his "Report on the Geology of Cornwall, Devon, and West Somerset."

During the last thirty-five years little or nothing has been published on these peculiar deposits, though many geologists have been struck with their singularity. It is because we have had many opportunities of examining sections of the beds, and ascertaining their exact extent, that we venture to bring this paper before the Society.

A reference to the accompanying map will show the position of these deposits round the foot of the hill known as St. Agnes Beacon, which is clay-slate or "killas," having a height of about 620 feet. Mr.


MAP OF
SAND AND CLAY BEDS,
AT St AGNES.
N
St Agnes H.
ATLANTIC OCEAN.
Lode
ELVAN COURSE
Cross Course
Lodes
Road
Sand
Clay
Clay
Sand
C
Road
Clay
Sand
Sand
Clay
GRANITE
Cross Course
Sand
Clay
Clay
The Beacon
Road
Lodes
Road
To St Agnes
100
200
300
400
Scale of Fathoms.

Hawkins, in the paper referred to above, gives the height of the beds of clay and sand as 375 feet above high-water at spring-tides. On the western side of the hill an isolated patch of granite occurs, which is for the most part so soft and decomposed as to yield china-clay on washing. It is at present used as a white fire-clay. The elvan course marked in the map dips north.

The main deposit of sand and clay extends as a broad belt around the north and east sides of the Beacon. Its length is about 1⅔ mile (1,250 fathoms); its width and thickness vary very considerably. Besides this there is a smaller deposit on the western side lying on the decomposed granite; the former rests upon the killas. Generally speaking, we may say it is a bed of sand resting upon the rock, having upon it a bed of clay, the whole being covered by "head" or overburden. The "head" is derived from the hill above, and is much the same as the soil and subsoil found upon the killas of Cornwall, except that it is somewhat sandy in parts, and occasionally contains washed pebbles.

The clay is of two kinds, candle-clay and fire-clay. The former is of a blue colour, and when of good quality is almost entirely free from grit, is plastic, adhesive, and very tough. It sells for about seven or eight shillings a ton at the pits; and a stock is raised in summer to last over the winter, when rainy weather makes it difficult to get it up.

The fire-clay is frequently also of a blue colour, but sometimes yellowish. It is coarse, owing to a

large admixture of sand and angular gravel, and we think may be regarded as candle-clay which has not undergone the necessary amount of washing, since on being washed it yields the latter of excellent quality, but before washing does not possess the indispensable qualities of toughness and adhesiveness. It is used in large quantities, both alone and mixed with the decomposed granite, especially in Wales, as a cement for building and lining furnaces, and is delivered at Welsh ports for eight shillings per ton.

The sand is nearly pure silica, sometimes coloured by oxide of iron. It is of various degrees of fineness, and in some cases we find the rougher particles at the bottom. The grains are always perfectly rounded and polished. It sometimes occurs quite white, but is found of almost all colours, the colouring matter being removable in most cases by washing with water, leaving the sand tolerably white; in other samples the colours are with difficulty removed by strong acids. The fine white sand is used by gardeners in potting, and is delivered in Truro at 17s. 6d. per ton. Much of it is shipped to London. The coarser is used by crucible manufacturers. The sand is also in request for mixing with mortar for building purposes, and for strewing over the lime floors of the cottages in the neighbourhood.

The pebbles which occur vary in size from that of a hazel-nut to the largest boulders, and in the smaller deposit are sometimes met with weighing a ton or more. A careful examination shows that they are all

from the local rocks; and the men working the pits assert that they have never seen a pebble but they can find its corresponding rock somewhere around the Beacon *in situ.*

The rock upon which the beds rest, where seen, is always worn smooth and polished, being evidently shingle-worn. In some parts it is exceedingly soft, and after exposure to the atmosphere for some time, crumbles away. In other parts it is much harder, and shows no tendency whatever to decomposition.

As all the pits sunk in the deposits are for the sake of the profits to be derived, and as the sand is not of a uniform marketable quality, it necessarily follows that upon many interesting points we lack information. Still, sufficient work has been done to enable us to understand the general nature of the deposits, and to give seven sections of different points, illustrating the characteristics of the beds. Six of these represent as many pits, and the other is a transverse section through the deposit. The situation of these several sections is marked by corresponding letters on the map. A, soil and head, 4 feet; blue fire-clay, 7 feet; candle-clay, 2 feet; sand, 5 feet, resting on killas. C, soil and head, 6 feet; candle-clay, 2½ feet; sand, 5 feet; clay, 3 feet; sand, 12 feet; sandstone, not gone through. D, head, 6 feet; clay containing few pebbles, 3 feet; sand, 12 feet; sandstone, 2 feet; sand with pebbles, not gone through. F, head, 6 feet; white candle-clay, 3 feet; gravel, 1 foot; white candle-clay, 2½ feet; yellow and whitish sand, not gone through. G, head, 5 feet; yellow sand, 2 feet;

red sand, 2 feet; white sand, 4 feet; pebbles in sand; not gone through. J, head, 9 feet; candle-clay, 20 feet; dark-red sand, 3 inches; yellowish sand, 2 feet; gravel, pebbles, boulders, and sand, 3 feet, resting on granite.

A comparison of these sections shows that the fire-clay in the main deposit is confined to the north and west. Both clays occur, but by far the greater part is fire-clay. Where both occur, the candle-clay is usually uppermost. In the section A, however, it is seen below; this is an exceptional case. The distinction between the two clays by stratification is always well-defined. Above the clay a thin stratum sometimes occurs, containing a number of quartz gravels; sometimes this is replaced by sand. In section A, the overburden is given as 4 feet; but going north the ground gradually falls, and we might give a section having one foot of soil resting directly on the clay. Around A, large quantities of sand and clay have been raised. We give a transverse section through the deposits at B, where the clay is not so gritty as at A, and seems to be gradually fining into candle-clay. In it nests and veins of beautifully white sand occur, imbedded in the clay; in other places, a floor or nest of very dark sand is found perfectly isolated, or a bed of dark sand contains a patch of perfectly white "silver sand." At or near the bottom we meet with sand, hardened and cemented together by oxide of iron, and taking a remarkable form, being not unlike the roots of trees, or rather the thick bark of trees squeezed flat. They are cores

PLATE V.

Section on line B B′

Scale, 200 fms to a foot.

THE UNIVERSITY OF MICHIGAN LIBRARIES

of sandstone with a centre of free sand, and were probably formed by water percolating through, having oxide of iron in solution, as they run in an easterly direction, and eastward we find a stratum of hardened sand for a great distance, at one place no less than six feet thick.

At C, and for the remainder of the deposit, candle-clay only occurs, and is here divided into two beds, separated by five feet of sand.

At D, the clay is in one bed. In it, and also in the sand below, large pebbles and angular stones are frequently met with. The sand, as seen in a pit section, frequently presents a striking appearance. For instance, in the depth of a foot we might get a stratum of red, followed by white, pink, yellow, blue, and other colours, with the lines of separation sharply defined; while the other side of the pit, a few feet off, would show the order reversed, or the whole replaced by light or dark sand of a uniform colour. The hardened sand is here two feet thick.

At E, clay only is raised, and varies in thickness from six feet to twelve feet. The overburden is exceptionally sandy, and contains large numbers of quartz pebbles, from the size of a marble to that of a walnut. From this point to the end of the deposit very little work has been done. In the section marked F, the clay is whiter than is usually the case, and in it is found a bed of gravel one foot thick. At G, we give a section beyond the clay. The sand here shows much the same changeableness in colour as at D, though not to the same extent.

At H, mining operations in 1875 exposed a cliff facing north, 16 feet in height, and 15 feet below the surface. The face was almost perpendicular, and bore strong evidence of having been shingle-worn for a considerable time, being washed into caves and hollows, and completely smoothed and polished. The rock exposed was much harder than the killas generally, being the outcrop of a lode, and a level driven into it cut sand again on the other side, proving it to have been a point jutting out into the deposit, having withstood the action which wore away the killas on either side. Old miners who worked around here for tin report that, from this point to K, a cliff stands facing east, having in it numerous hollows; and from the appearance presented at H, this seems highly probable. The sand here contained very large pebbles and boulders, and also angular fragments of rock.

It will be seen that section J is through the smaller deposit on the granite. It lies in a basin in the granite, and it is here that the clay reaches its greatest thickness. To the west and south of this point a great number of granite boulders are found lying on the mine burrows, brought to the surface in mining operations; and nests of tin-stone pebbles have been found in hollows in the granite between these boulders and the clay deposit. These are evidences that the sand and clay beds at one time extended further than at present—how much further it is impossible to say—and that they have been brought to their present limits by denudation.

We have stated that all the pebbles found are from

the local rocks; they consist of killas, quartz, tourmaline schist, &c. We may go farther, and say that the pebbles found vary with the different districts, and may often be referred to the rock above which they lie. This is particularly apparent in those found at H. The lodes running through the district tend to confirm this. Thus no tin-stone pebbles have been found in the deposit at A or B, only one at C, while from H to D and G, and to the north, great numbers have been met with; in fact the ground has been extensively turned over by the "old men" for the sake of the tin, called by them "gurries." These may be referred to the Wheal Trevaunance, and other tin lodes to the north, which were particularly rich near the surface. Again; the tin lodes in Wheal Coates, in the granite, have produced tin very shallow, and the pebbles and boulders of the smaller deposit are described as being of "hard capel rock, with quartz and tin-stone," and have been worked to a large extent for tin, as the large burrows of pebbles at the surface testify. The mode of working was to sink to the bed of gravel, and then with suitable rakes remove it from as large an area as possible; but owing to the frequent occurrence of the huge boulders before mentioned, these operations could not be carried on at a profit, as they impeded the free use of the scrapers.

We have found it difficult, from the unique nature of these deposits, to arrive at a conclusion as to the manner in which they were formed. The weight of evidence points to a sheltered arm of the sea, into

which a river emptied its waters, and deposited its mud.

So far as we have been able to ascertain, the only traces of either animal or vegetable life which these beds have ever yielded, are confined to some indistinct markings, somewhat resembling sea-weed, on a piece of clay about four inches square, and a black substance in pellets a little larger than peas; these last, however, have not turned up lately, and we have not succeeded in getting a specimen to examine.

REMARKS ON SOME TIN LODES IN THE ST. AGNES DISTRICT.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.,
One of H.M.'s Inspectors of Mines.

Though several of the mines in the St. Agnes district have been described from time to time by competent observers, and especially by the late Mr. Henwood, I think there is still room for further remarks upon the mineral phenomena of the parish, and for the following reasons: in the first place, the lodes can now be studied at greater depths than formerly; secondly, other lodes are in some cases being wrought; and thirdly, there is a great want of cross-sections of the lodes in the previous descriptions I have met with. I do not for a moment pretend to give a thoroughly exhaustive account of any one of the lodes I have visited. Such an account could only be written by one who had constant opportunities of observing a lode in all its different phases, which vary from week to week, and even from day to day. I simply hope to be able to add something to the general stock of information concerning the St. Agnes district, trusting that those who have more frequent occasion than I have to examine its mines,

will do their share in giving us fuller descriptions of the manner in which the tin ore occurs.

As it is much easier to convey an idea of a lode by a sketch than by words, I propose to give a series of diagrammatic sections rather than long verbal explanations.

PENHALLS MINE.

Penhalls Mine, situated on the edge of the cliff just east of Trevaunance Cove, is singularly interesting on account of the numerous "heaves" which occur there, as described by the late Mr. J. W. Pike.* My object is to explain the structure of the principal lode in the mine, known for the last hundred years at least as the Pink lode. In the old Wheal Pink, which is included in Penhalls sett, there were three separate and distinct lodes more or less parallel to one another, and at most a few fathoms apart. The main lode at Penhalls, called Cowling's lode in Mr. Pike's section, is the middle one, and his "flat lode" is the upper division. The former has a general run or strike of 35° N. of W. (true), and it dips north about 33° on an average; varying, in fact, from 25° to 55°.

Fig. 1 (plate vi.) is a sketch of the lode as seen in some stopes above the 45-fathoms level.

AA is the killas with a southerly dip of 20°.

BB is *capel*.

CC is the *leader*.

The word *capel* is applied to a rock which appears

* *Quarterly Journal of the Geological Society*, vol. xxii., p. 535.

to me to be simply a highly-altered killas—a killas which has been greatly acted on by mineral solutions, and changed from a soft slaty rock into a hard, dark-coloured, compact mass of quartz and schorl, these minerals being arranged in streaks following the original lines of stratification of the killas. In addition, the capel is generally full of short lenticular veins of quartz, and is intersected by numerous little strings of cassiterite and chlorite.

The *capel* is generally found on both sides of the *leader* CC, and in the present instance varies from nothing to 2 feet in thickness. In places for a short distance, as shown in the figure, there is no *capel* at all, and the ordinary killas abuts directly against the *leader*.

CC, the *leader*, varying from 4 to 15 inches in width, consists of quartz, cassiterite, chlorite, a little iron pyrites, and pieces of *capel*.

Here then we have the simplest case, and the successive operations which brought about this result may be supposed to have happened as follows:

1. Formation of a fissure through the killas.

2. Shifting of the walls, producing open spaces, and squeezing and contorting the edges of the strata at the sides of the crack.

3. Arrival of mineral solutions from below, which *soaked into the walls*, and gradually converted the rock on each side into *capel*.

4. Deposition of tin ore and other minerals in the open fissure, and in minor cracks in the capel.

Sometimes the killas between the main Pink lode

and the top lode, for a thickness of 12 to 14 feet, is full of small branches containing cassiterite, and in that case both the lode and *country* are stoped away.

In Fig. 2 (plate vi.) we have a sketch of the lode seen in some stopes above the 60-fathoms level, and considered to be the bottom or undermost division of the Pink lode as known in the old mine. The lode has a higher dip than usual.

AA again represents soft killas dipping south.

BB, *capel* on the hanging wall side, with lenticular veins of quartz, and strings of cassiterite, chlorite, and copper pyrites.

CC, very hard *capel* on the foot wall side, with numerous short, thick, irregular veins of white quartz, traversed by innumerable strings of cassiterite, chlorite, and copper pyrites.

DD, rich vein of tin ore, quartz, and chlorite, with *vughs* or cavities containing fine needles of bismuthine.

EE, blende, tin ore, chlorite, and a little iron pyrites.

FF, narrow vein of copper pyrites.

GG, tin ore and quartz, with spots of copper pyrites.

The *capel* is therefore much the same as in the preceding case; but the actual lode itself, or filling up of an open fissure, presents a more complex appearance. This may of course be explained on the supposition that there were several periods of deposition; in other words, that the fissure, after having been filled up, was re-opened, and minerals

again crystallized out from vapours or solutions coming from below.

The average produce of the stuff stamped at Penhalls—which of course consists of lode, capel, and some killas with strings of cassiterite—may be stated to be about 53 lbs. of black tin per ton of stuff, or very slightly more than $2\frac{1}{3}$ per cent.

WHEAL KITTY.

Wheal Kitty, which lies to the south of Penhalls Mine, is mainly dependent on one lode, known as the Kitty or Pryor's lode. It strikes about 32° N. of E. (true), on an average, though the bearings may vary from 20° to 45° N. of E. The dip is from 10° to 45° north, the average being about 30° (underlie 5 ft. 2 ins. per fathom).

The Kitty lode presents decided points of resemblance to the Pink lode, from the fact that there is generally a *leader* with a *capel* on each side.

Fig. 3 (plate vii.) shows a section of the Kitty lode in some stopes above the 118-fathoms level.

AA, killas, dipping south.

BB, capel.

CC, small leader or vein of tinstone and quartz, from nothing to 1 in. thick.

DD, leader of iron pyrites, tinstone, and chlorite, containing about $2\frac{1}{2}$ per cent. of tinstone. In some parts of the mine the iron pyrites dies away, and you have a leader 1 ft. thick, containing 50 per cent. of tinstone, the remainder being quartz and capel.

The small vein CC bends down going north, and

drops into the lode again; and to the south also it unites with the leader DD, forming a rich bunch.

The capel is similar in nature to that of Penhalls. It is also traversed by veins of quartz and strings of tinstone, chlorite, and iron pyrites. Occasionally there is a distinct wall between the capel and the killas on the hanging side.

The next figure, No. 4 (plate vii.), is an instance of an exceedingly flat lode; for the dip is only 10°.

AA, killas, dipping south.

BB, capel.

CC, very rich vein of tinstone, about ½ in. thick.

DD, so-called leader, with no distinct footwall. It is mainly a dark, compact mixture of quartz, schorl, tinstone, and altered killas, and resembles a capel, though less veined with white quartz than that rock usually is.

During my last visit to Wheal Kitty, I discovered some specimens of apatite, a mineral which had previously been found only at one mine in the parish; viz., Wheal Kine.* The occurrence of schorl also deserves attention; for it appears to be invariably present in the capels. I have thought it better to retain the local name *capel*, than adopt the term *quartzose slate* employed by Mr. Henwood.

Two specimens which I obtained from the Kitty lode afford some information concerning the order in which the various minerals were deposited. The first shows the following series: 1. Cassiterite; 2. Iron pyrites; 3. Chlorite. The second: 1. Quartz; 2.

* Included in the present Polberro sett.

Cassiterite; 3. Tourmaline; 4. Apatite. The apatite encloses needles of tourmaline, and must therefore be the last-formed mineral of the group.

Besides the minerals already mentioned, copper pyrites, blende, fluor, and chalybite occur at Wheal Kitty. The last two are not very common.

The sections I have given of the Pink and Kitty lodes are interesting, as the dips are much less than the average inclination of the mineral veins of the county. I may here remark that at St. Agnes Consols Mine, which is considered to have reached the continuation of the Kitty lode to the west, I have seen the vein perfectly flat for a short distance, and for 30 fathoms dipping at an angle of only 5° from the horizontal.

The average produce of the stuff stamped at Wheal Kitty is about 83 lbs. per ton; or, in other words, it affords 3·7 per cent. of cassiterite.

WHEAL COATES.

The name of this mine sounds very familiar to all mineralogists, as the birthplace of the splendid pseudomorphs of cassiterite after orthoclase, which are found in so many collections. It is not my purpose, however, to say anything about their occurrence, as the subject has been treated in the *Transactions* of this Society,* as well as in those of the Royal Institution of Cornwall;† but the lode which is now

* Vol. iv., p. 484.

† *Ann. Rep. Roy. Inst. Cornwall*, No. 27, p. 20. 1854.

being wrought at Wheal Coates, the Towanrath lode, has not, as far as I am aware, ever been described; indeed, until within the last few years, scarcely anything had been done upon it for some three centuries at least.

The back of the lode crops out at the edge of the cliff, close to the present pumping-engine, and a capital view of the section in the cliff may be obtained by descending through the large cavern, known as the "Vugga," formed by old workings, and going out on to the beach at low tide. The lode is seen dipping in a southerly direction, with a marked elvan on the hanging wall side. In depth the lode becomes steeper, and leaves the elvan, the position of which has not been accurately determined below the adit level.

The average strike of the Towanrath lode is about E. 24° N. (true), and the dip about 80° south.

Fig. 5 (plate viii.) shows a general section of the lode.

AA is the lode proper, from 2 to 12 ft. wide, consisting mainly of quartz, with patches and veins of brown and red hematite, and spots of white and red clay. In places the lode is rich for tin; but the greater part of the mineral is derived from the killas, BB, on the hanging wall side. The enclosing rock or *country* is here full of little veins of white clay (*prian*) and cassiterite. Many of the little strings are not thicker than a knife-edge, others $\frac{1}{8}$ in. or even 1 in. wide. A large number of the strings underlie north, but it cannot be said that there is any general direction, for their dips and strikes are quite irregular; in fact the killas is traversed in all sorts of ways by these

tinny branches, which extend from two to four fathoms south of the lode. Sometimes the two fathoms of rock adjoining the lode contain few branches, whilst the ground further away is rich in them, or *vice versâ.* The veins contain also a little iron pyrites, and occasionally some of the killas is converted into a hard *capel,* consisting mainly of quartz and schorl.

The killas, CC, on the footwall side is either destitute of tinny veins or contains very few.

This deposit of tin forms what German writers call a *stockwork,* and French geologists an *interlaced mass.* Taking the whole of the stuff stamped, there is an average produce of $1\frac{1}{4}$ per cent. of tin ore.

Before proceeding to the last part of my paper, I must express my best thanks to Captains S. Bennetts, S. Davey, and W. H. Martin, for having kindly afforded me much information concerning their respective mines.

CLIGGA.

The section that can be seen at low tide on the western side of the Cligga promontory, is one of the most remarkable in the county, and of course attracted the attention of geologists many years ago, and has continued to do so ever since.

In a paper read nearly sixty-three years ago before the Geological Society of London,* Mr. Conybeare not only described the section, but also illustrated it by a plate copied from a drawing by Dr. Buckland.

---

* *Trans. Geol. Soc.,* vol. iv., p. 401.

Mr. Joseph Carne naturally did not let this interesting district pass unnoticed in 1818, when recording his observations on Cornish veins.* In 1820, Professor Sedgwick wrote at some length on Cligga in his well-known "Memoir on the Geology of Cornwall,"† and he was followed in 1829 by MM. von Oeynhausen and von Dechen.‡ Mr. Henwood,§ in 1838 and 1843, published his views on the question. In 1839 we come to Sir Henry De la Beche's account;|| and finally, in 1843, to some notes on Cligga by Mr. Whitley.¶

After such an array of well-known names, it may appear presumption on my part to say any more on the subject; but I cannot help feeling that the existing descriptions are all of them more or less unsatisfactory, either from want of correct illustrations, or from mistaken notions concerning the origin of the rocks, and the deposits they enclose.

Mr. Conybeare, it is true, gives a sketch, but it is a very general one, and he speaks of the "stratification" of the granite. The Cligga headland is said by Mr. Carne to consist of "elvan," and the tin veins are supposed by him to have been formed contemporaneously with the rock. Professor Sedgwick seems to have had the most correct idea, as he describes

---

* *Trans. Roy. Geol. Soc. Cornwall*, vol. ii., p. 80.

† *Camb. Phil. Trans.*, vol. i., p. 132.

‡ *Phil. Mag. or Annals, &c.*, vol. v., p. 169.

§ *Ann. Rep. Roy. Inst. Cornwall*, No. 20, p. 29; and *Trans. Roy. Geol. Soc. Cornwall*, vol. v., p. 94.

|| *Report on the Geology of Cornwall, Devon, and West Somerset*, p. 164.

¶ *Ann. Rep. Roy. Inst. Cornwall*, No. 25, p. 34.

the granite as being intersected by innumerable parallel metalliferous fissures, but unfortunately he gives no details concerning them, and no diagrams.

MM. von Oeynhausen and von Dechen looked upon the section as exhibiting a series of granite veins intersecting the granite.

Mr. Henwood uses the expression "beds of granite;" but he evidently considered the granite to be jointed, and not stratified. In the description furnished by Sir H. De la Beche, we read simply of "alternations of hard and decomposed granite;" whilst the woodcuts supplied by him, and also by Mr. Whitley, fail to convey an accurate representation of all the facts that may be observed.

This being the state of the case, I beg leave to be allowed to express my views on the subject, and fill up some of the gaps that have been left by former observers.

Cligga point is a mass of granite. On the west side of the promontory the cliff section can be studied for a distance of more than a quarter of a mile at low water; and I will suppose that we have reached the shore near the northern part of the headland (A, Fig. 10, plate xi.), by the little path made by miners, who wash out tin ore from the sand and gravel lying among the boulders on the beach.*

The granite cliff, which is about 300 feet high, is here intersected by a series of more or less parallel veins, dipping north at angles of from 65° to 80°, and

* On one of my last visits I found that the men had adopted the "cradle" for this purpose.

striking from 20° to 30° N. of E. (true). Before proceeding any further, let us examine the details of any one of them, as shown in Fig. 6 (plate viii.). AA is a vein of quartz, in this case three inches wide, the crystals starting from each wall, and either joining in the middle, or leaving an open cavity or *vugh*. CC is a light grey granite, with marked crystals of orthoclase, whilst between the granite and the quartz vein you have on each side a band of dark rock, BB, four inches in width. This dark band is *greisen*, a rock composed simply of quartz and mica; in other words, it is a granite minus the felspar. It often contains a little schorl and tinstone, in addition to its two regular constituents. There is no sharp *wall* or plane of separation between the granite and the greisen, as there is between the greisen and the quartz vein. Besides quartz, the veins contain cassiterite, wolfram, schorl, lithomarge, lepidolite, and mispickel; and the honeycombed state of the cliff testifies to the fact, that it has been thought worth while to carry on mining operations for working some of the best of the little lodes.

The cliff section exhibits a countless number of these veins, varying from ½ inch to 6 inches in width, and from a few inches to a few feet apart.

In the case illustrated by Fig. 7 (plate ix.) we have three parallel veins, CC, each about ½ inch wide, with 2 or 3 inches of greisen, BB, on each side, and granite, AA, between the bands of greisen. The orthoclase of the granite is generally decomposed into kaolin, and the rock rendered so soft that it crumbles away,

leaving the greisen bands projecting. Occasionally, however, some of the orthoclase has resisted the decomposing agencies, and stands out in hard crystals, while the rest of the granite weathers away.

Fig. 8 (plate ix.) shows another common occurrence. A little vein, BC, drops into another vein, DD, as its dip is rather greater; and when the veins are close to one another, E and F, there is no granite, and nothing but greisen between them. If a number of veins are in close proximity, you may have bands of greisen many feet in width. Here and there beautiful examples of faults are met with, as shown in Fig. 9 (plate x.), for instance.

Following the cliff to the south, we find that the direction of the dip of the veins gradually changes, veering round to the west and south-west, whilst at the same time the amount is considerably reduced. Further south again the veins resume their previous dip and strike. In fact, the veins dip so as to form an anticlinal curve succeeded by a synclinal, the axes of which incline to the west. The effect of this double curvature of the veins is shown in the north and south section, Fig. 10 (plate xi.). I have not attempted to portray even a tithe of the veins that exist in nature; I merely wish to indicate in a general way the appearance of the face of the cliff. At the point B the greisen is very chloritic, and you find pseudomorphs of chlorite after orthoclase. At C there are some very strong bands of greisen. Finally the granite abuts against the killas, D, which is here a good deal altered, veined with quartz, and very

schorlaceous; much of it may be called tourmaline schist.* A fallen block of this rock afforded me a few small particles of molybdenite, which has not, as far I am aware, ever been found in the district before.

In conclusion, let me say a few words in explanation of the magnificent section at Cligga; and I use the word 'magnificent' advisedly. I have no hesitation in calling it one of the finest in the county of Cornwall, and indeed I doubt if any country in the world can exhibit a section more full of interest to the student of tin lodes.

I suppose the granite to have been once in a soft state, and whilst in that condition to have broken through the killas. As it cooled it contracted, leaving a series of small fissures; these formed channels for vapours and solutions proceeding from below, which not only deposited the minerals, quartz, cassiterite, &c. in the open cracks, but also decomposed the bounding walls. The granite near the fissures was totally changed, and converted into greisen; whilst a little further from them the felspar was simply decomposed, and altered into kaolin. We thus get greisen walls to each vein, and decomposed granite between the greisen walls of two adjacent veins. This solution of part of the problem is not new in a general way, as will be seen by consulting extracts from papers by Professors Daubrée and von Cotta, which I quoted in my little memoir on East Wheal Lovell last year; †

* The cliff section can be studied still further south along the beach as far as the well-known elvan course.

† *Transactions of the Royal Geological Society of Cornwall*, vol. ix. pp. 174, 175.

at the same time, I believe that the phenomena observed at Cligga have not previously been explained in this manner. The curvature of the veins is undoubtedly curious, though it finds a parallel in the variously-inclined tin lodes of Zinnwald, and in the concentric stratiform jointing which is often observable in granite. The variation in the direction of the Cligga fissures may perhaps be due to the position of the cooling surface of the killas, which must at one time have covered the granite entirely.

Fig. 1.

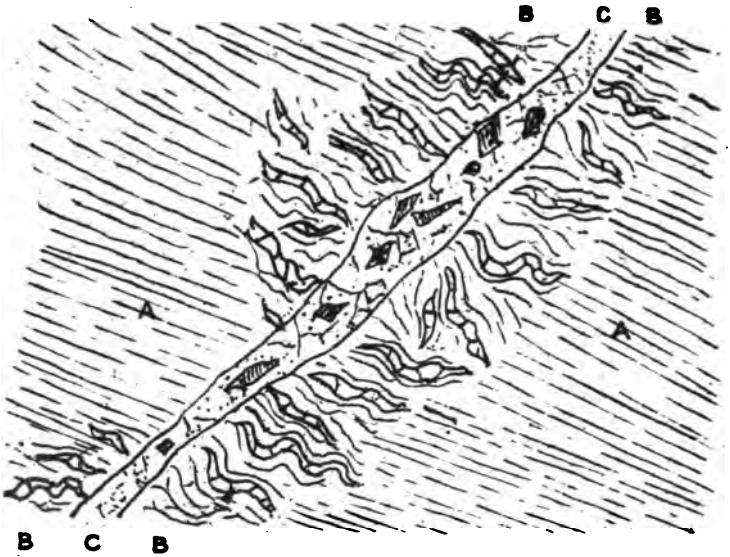
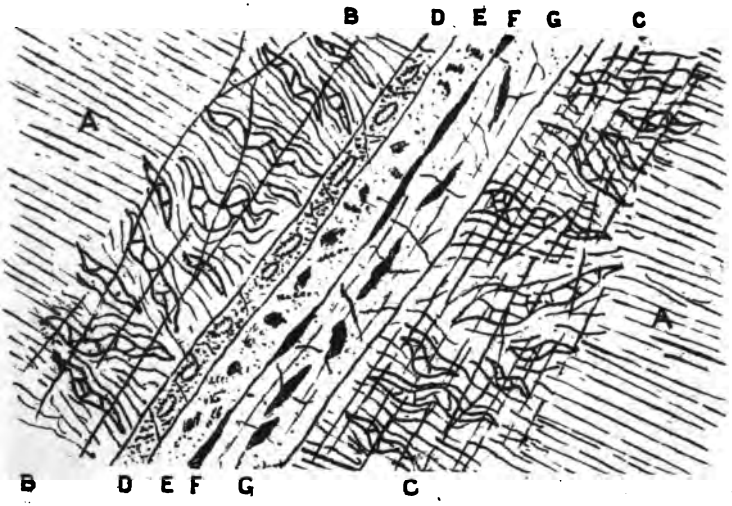


Fig. 2.



Scale ⅙

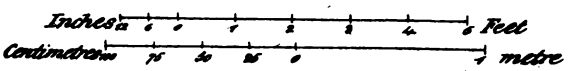


Fig. 3.

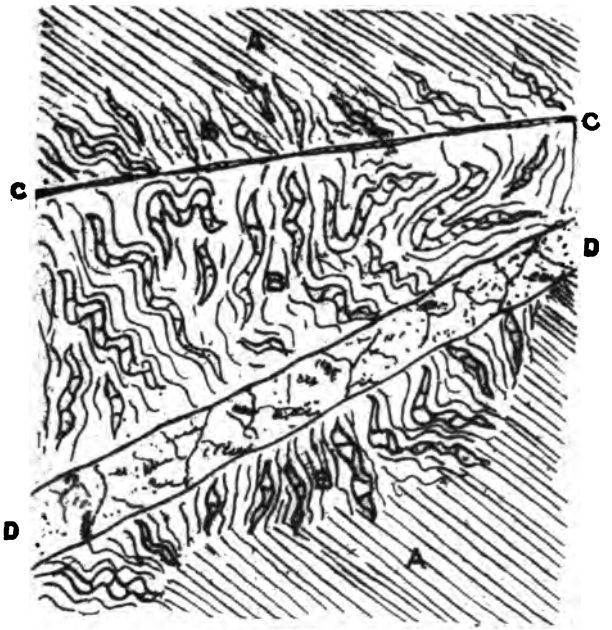
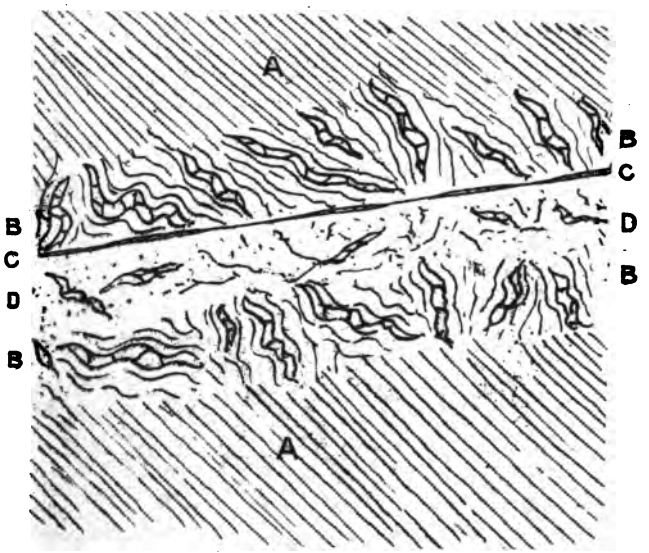


Fig. 4.



Scale to

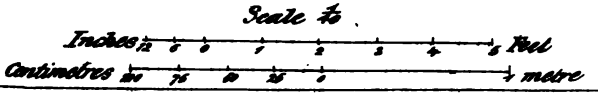


Fig. 5.

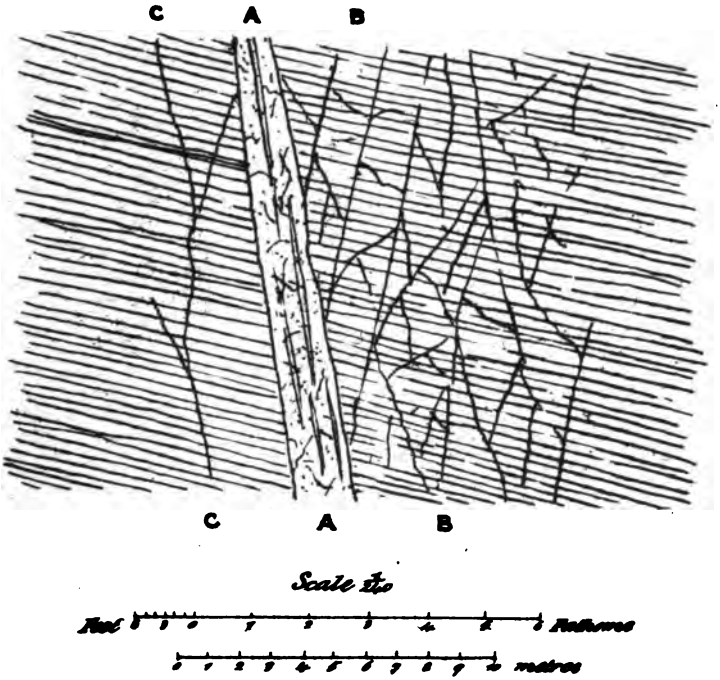

C
A
B
C
A
B
Scale 1/40
Feet
Fathoms
metres

Fig. 6.

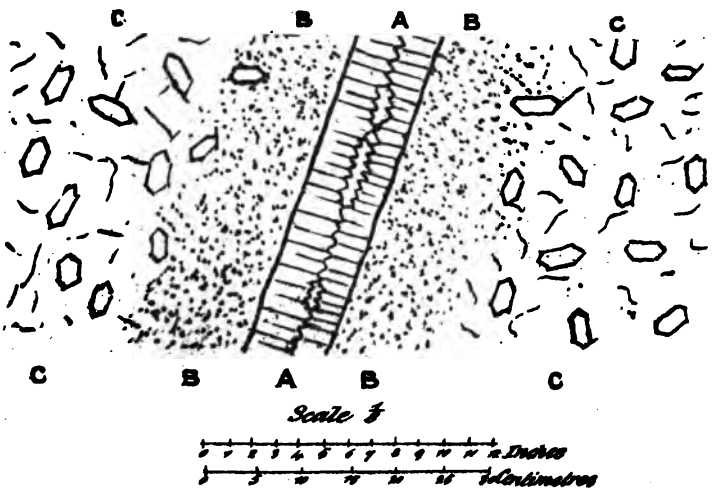

C
B
A
B
C
C
B
A
B
C
Scale 1/4
Inches
Centimetres

Fig. 7.

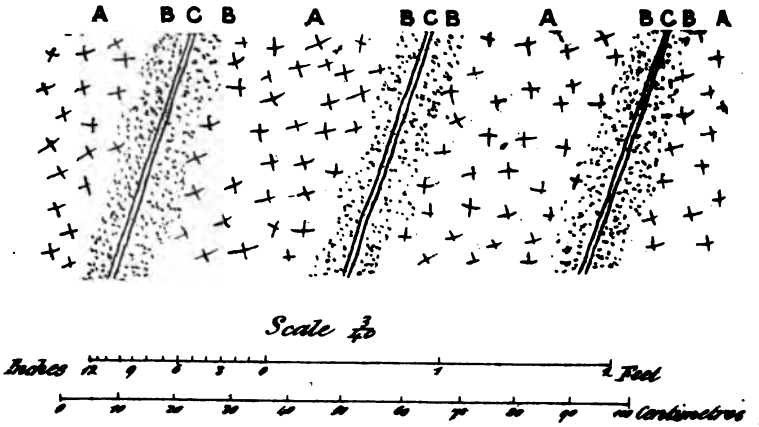

A
B C B
A
B C B
A
B C B A
Scale 3/40
Inches
Feet
Centimetres

Fig. 8.

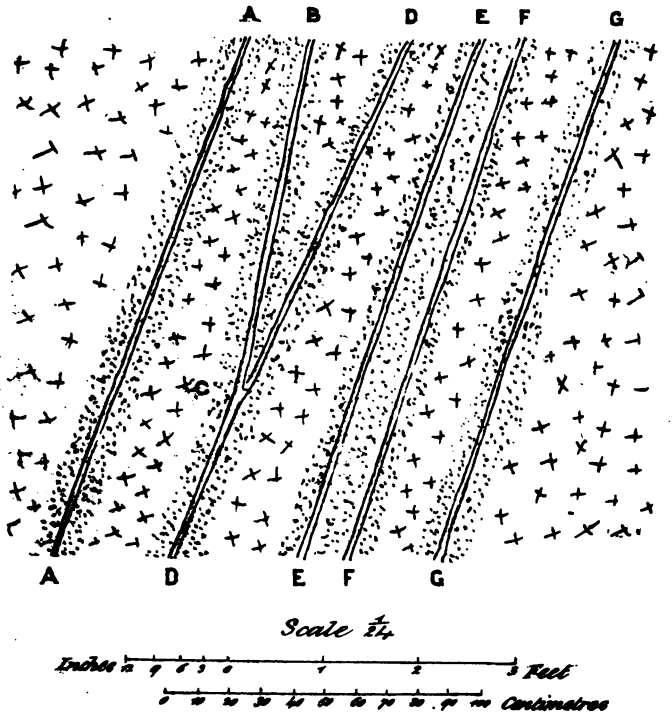
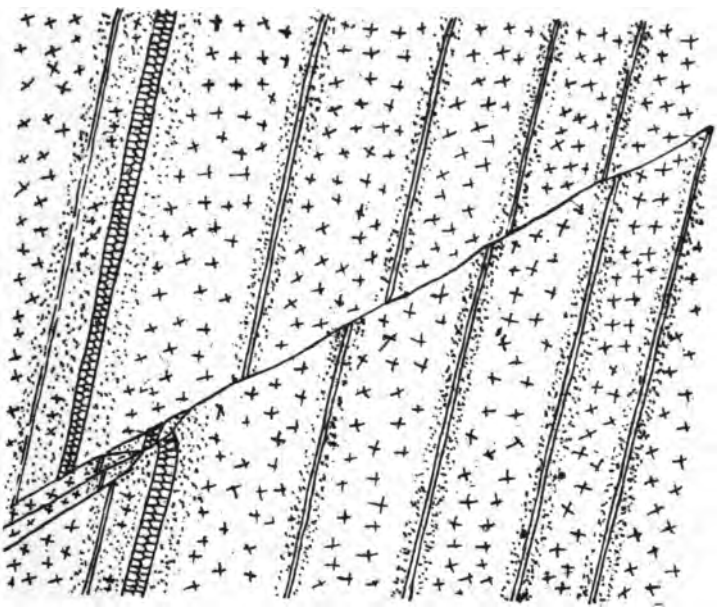

A
B
D
E
F
G
C
A
D
E
F
G
Scale 1/24
Inches
Feet
Centimetres

Fig. 9.



Scale $\frac{1}{90}$

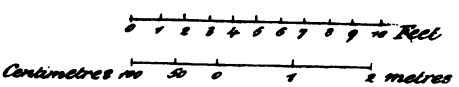


Fig. 1.

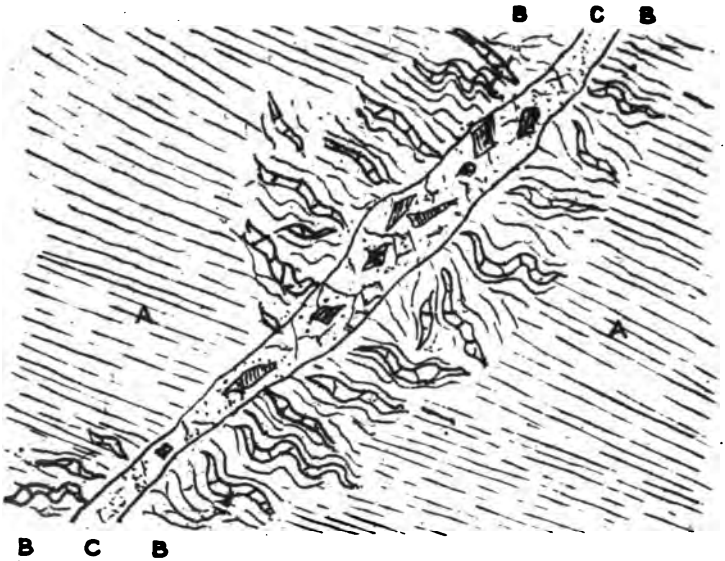

B C B
A
A
B C B

Fig. 2.

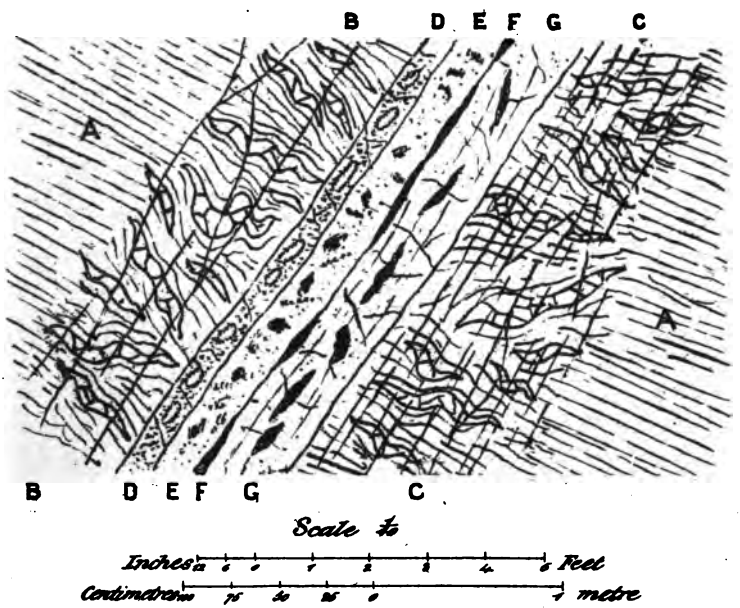

B D E F G C
A
A
B D E F G C
Scale 1/6
Inches
Feet
Centimetres
metre

Fig. 3.

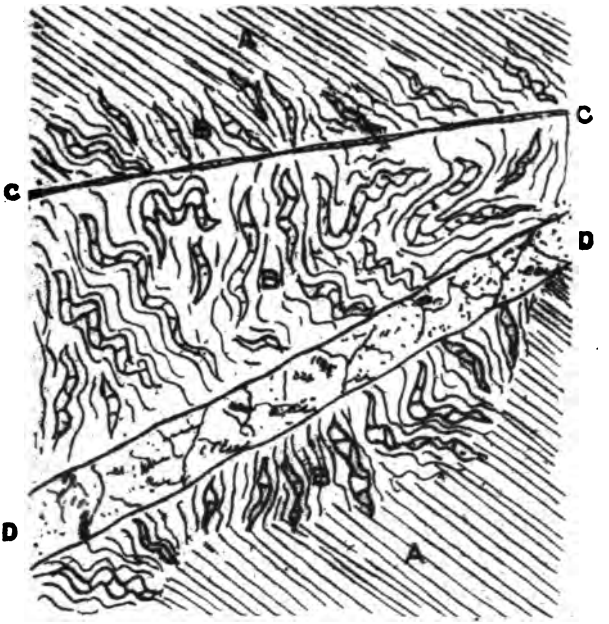
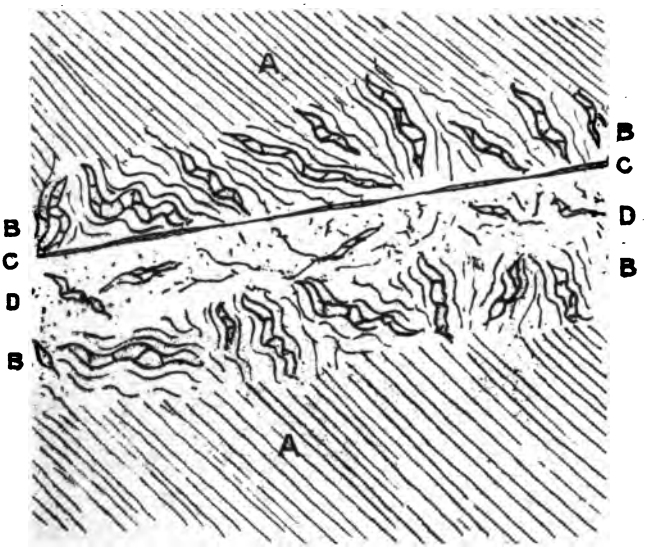


Fig. 4.



Scale $\frac{1}{10}$.

Inches $\frac{1}{12}$ 0 $\frac{1}{6}$ $\frac{1}{3}$ $\frac{2}{3}$ 1 2 3 4 5 Feet

Centimetres $\frac{1}{30}$ $\frac{1}{15}$ 10 20 30 $\frac{1}{3}$ metre

Fig. 5.

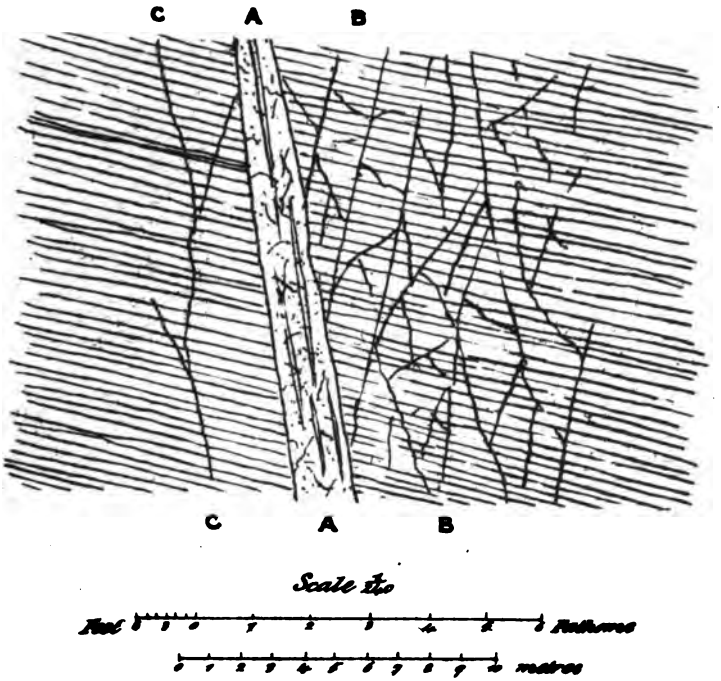
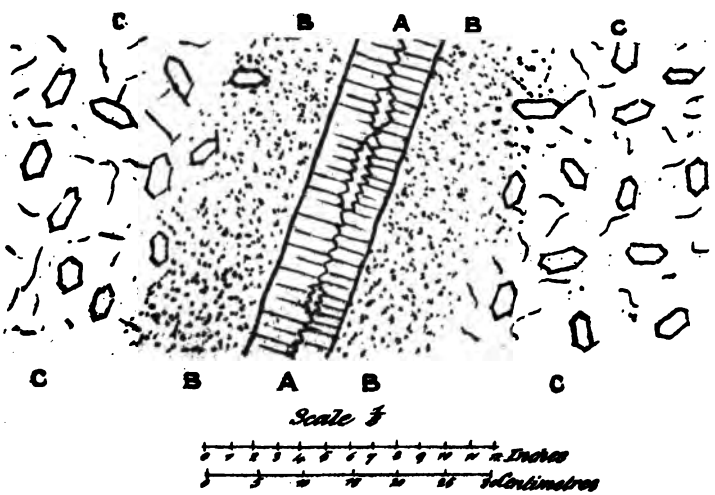
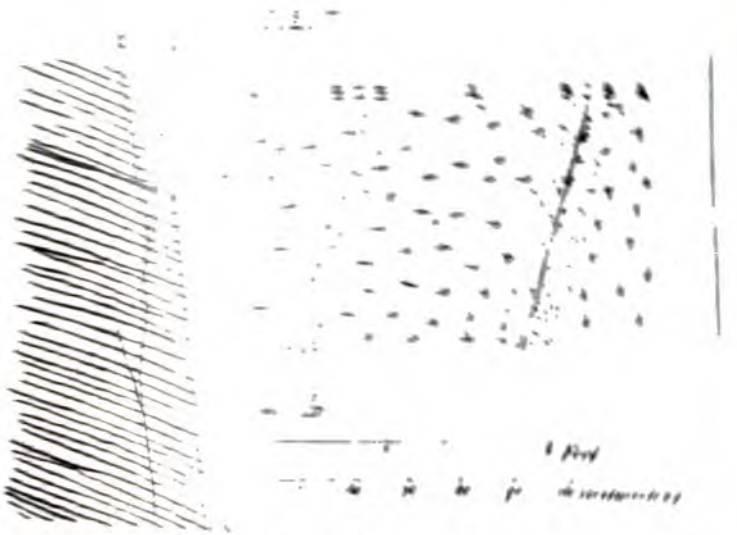

C
A
B
C
A
B
Scale 1/20
Feet
Fathoms
metres

Fig. 6.


C
B
A
B
C
C
B
A
B
C
Scale 1/1
Inches
Millimetres



C
D
E
F
Scale
Fig. 6
C
B
C
B
A
B
Scale

Fig. 7.

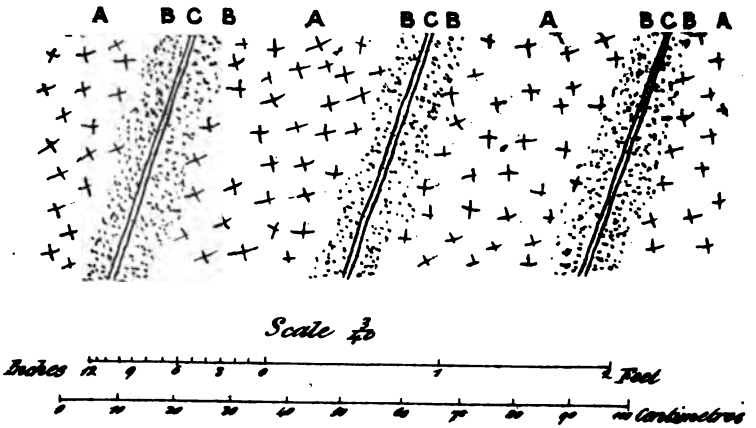

A B C B A B C B A B C B A
Scale 3/40
Inches
Feet
Centimetres

Fig. 8.

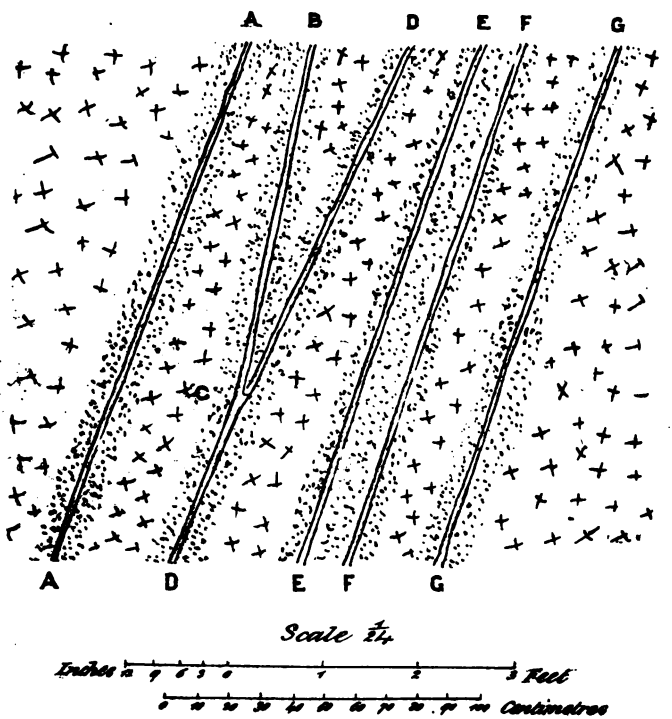

A B D E F G
C
A D E F G
Scale 1/24
Inches
Feet
Centimetres

Fig. 3.

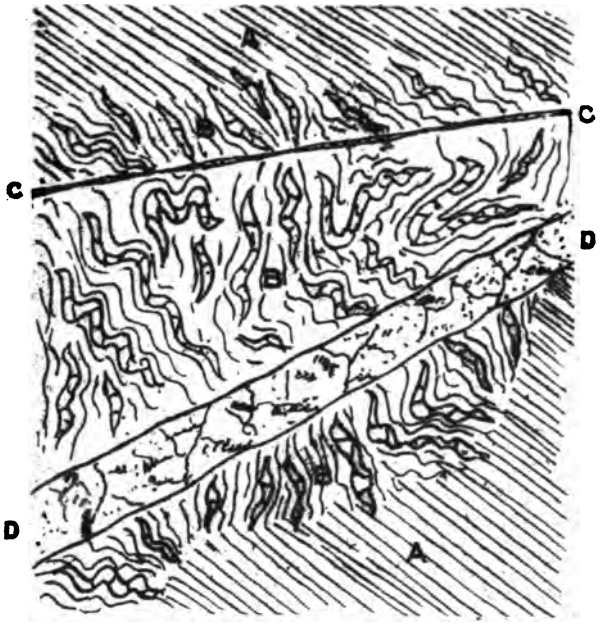

A
C
C
D
B
D
A

Fig. 4.

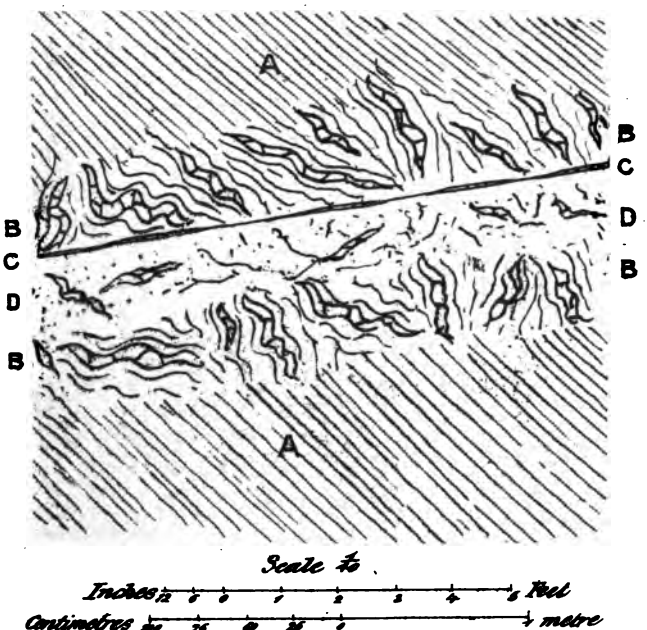

A
B
C
D
B
B
C
D
B
A
Scale 1/10
Inches 12 6 0 1 2 3 4 5 Feet
Centimetres 100 75 50 25 0 1 metre

Fig. 5.

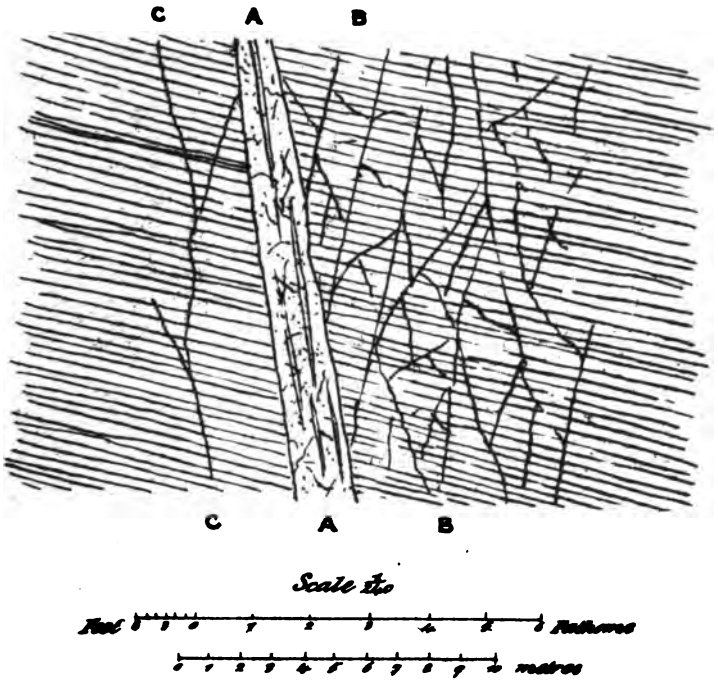

C
A
B
C
A
B
Scale 1/40
Feet
Fathoms
metres

Fig. 6.

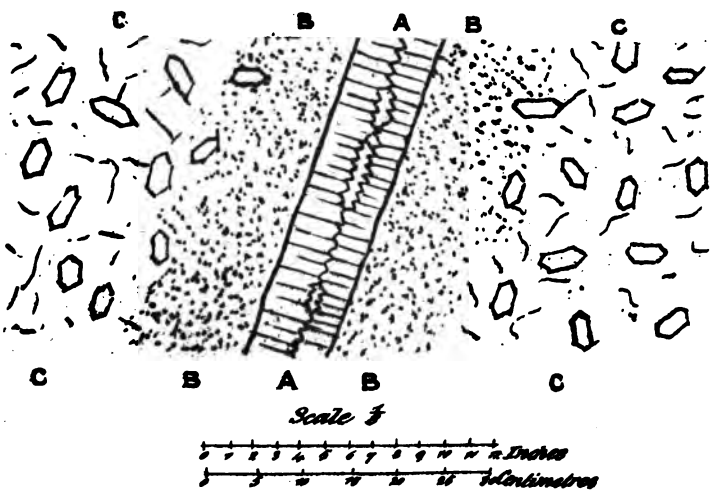

C
B
A
B
C
C
B
A
B
C
Scale 1/1
Inches
Centimetres

Fig. 7.

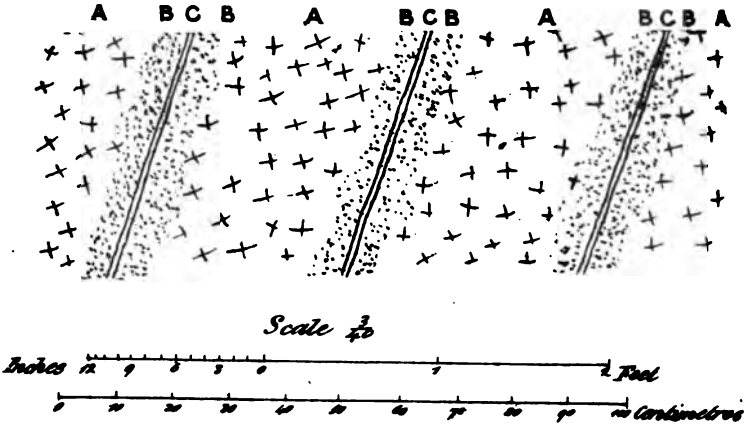

A
B C B
A
B C B
A
B C B A
Scale 3/40
Inches
Feet
Centimetres

Fig. 8.

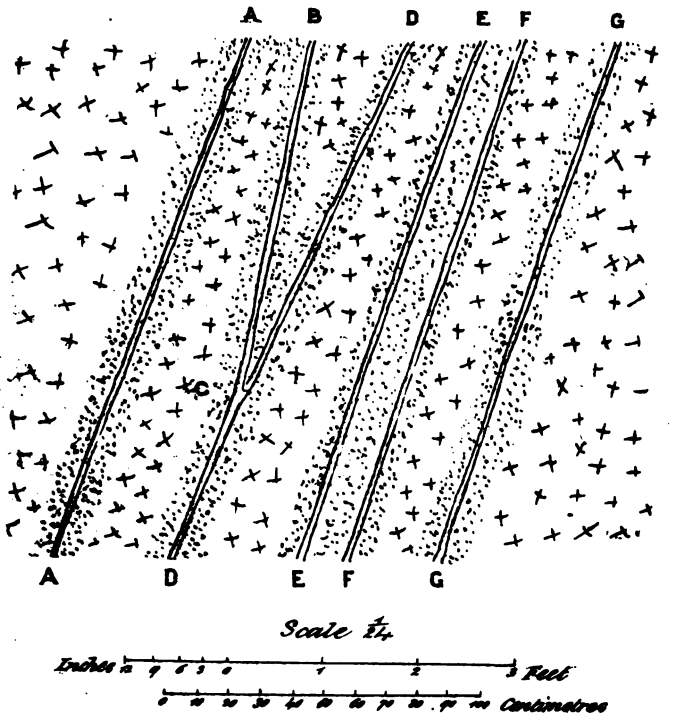
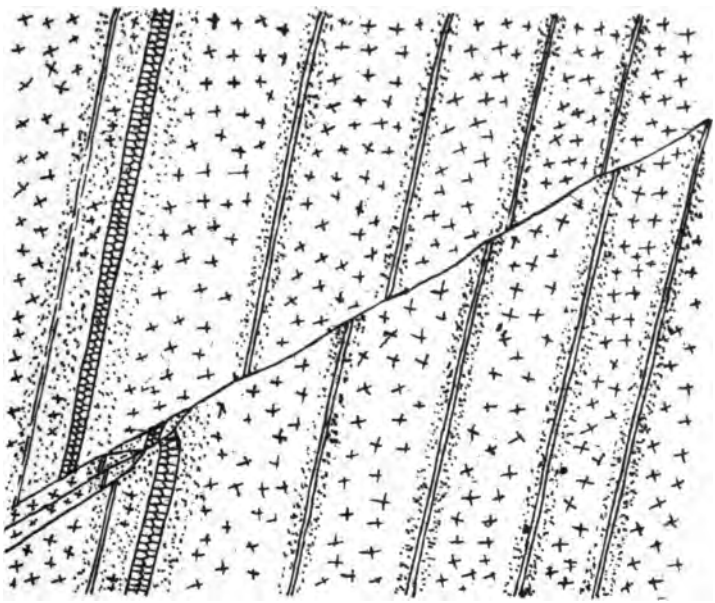

A
B
D
E
F
G
C
A
D
E
F
G
Scale 1/4
Inches
Feet
Centimetres

Fig. 9.



Scale $\frac{1}{96}$

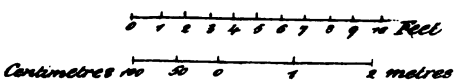
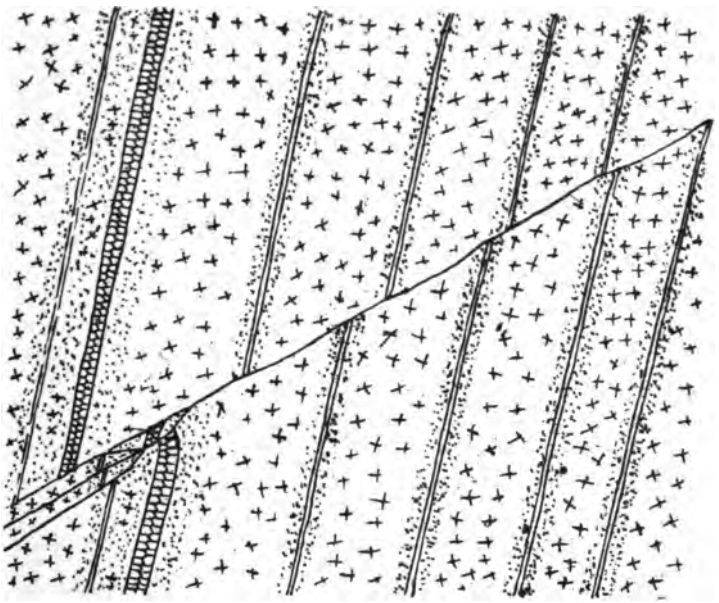
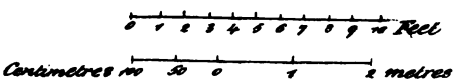


Fig. 9.



Scale $\frac{1}{40}$



Royal Geological Society of Cornwall.

Transactions, v. 7

FOR

FIFTY-FIRST, FIFTY-SECOND, FIFTY-THIRD,

AND FIFTY-FOURTH

ANNUAL REPORTS

OF THE COUNCIL,

WITH THE

PRESIDENT'S ADDRESSES,

&c., &c.

Penzance:

PRINTED BY T. CORNISH, BOOKSELLER AND STATIONER.

1868.

THE PRESIDENT'S ADDRESS

ON

LAYING THE FOUNDATION-STONE OF THE ROYAL CORNWALL GEOLOGICAL HALL, PENZANCE,

28th April, 1864.*

You will have seen, from the mode in which I laid the foundation-stone that I was not "to the manner born,"— that I am not of "the gentle craft" of the "Free and Accepted Masons";—that distinguished association of men who consecrated the hammer of Thor to Christian uses, and in the middle ages, in a time of almost universal ignorance, adorned the domain of the Latin Church with those ecclesiastical structures which were the admiration of the past, as they are of the present time. We will not pry into their mysteries; but we know the secret of their success—intelligence to calculate the weight and pressure of the loftiest arches, the size and strength of columns, and the resistance of buttresses;—the most perfect order and union; and above all, in its more eminent men submission to authority.

Michelet says, "View one of those cathedrals, ascend to its aerial desert, mount to the point of one of its pinnacles, where the tiler ventures only in trembling, there you may find some chef d'oeuvre of a pious workman, seen by the eye of Heaven alone; not a mark, a sign, or a letter of his name. He devoted his life to the work (as he supposed) only to glorify God, and 'for the good of his own soul.'"

Honour, then, to the Fraternity, which in the present day, with aims better directed, retains the emblems of certainty and power with which it once accomplished so much, and of the testing of human actions by the truth-telling plumb-line and square of principle.

* From memory and newspaper.

It would have been more fitting that fair hands should have laid the foundation of this building. Ladies launch vessels that they have not built and will not navigate; with much greater reason should the generous donor of the ground on which the Geological portion is to stand—the daughter of one who was so long their valued Treasurer, Joseph Carne—have performed the ceremony.

Whilst the coins of the realm, beginning with a sovereign and ending with a farthing, were successively dropped, with the list of Presidents, into the bottle, I was thinking how unworthy I was of being one of them. Commencing with Davies Gilbert as the gold coin, and descending to myself, the smallest of the copper coinage. As the conclave of Cardinals choose the least executive and most innocuous of their number as Pope, so may the office have fallen on me, in this the jubilee-year of the Geological Society; as you may have learned from the inscription which has been read that half a century has elapsed since Dr. Paris brought it into the world in the infancy of all Geology.

This deposit of a parchment memorial, whilst it reminds us of the olden time, also contrasts with it. In the British Museum I have seen a terra cotta cylinder which Sir H. Rawlinson drew out of the angle of a temple on the Euphrates. It records, in a language nearly allied to that of the ancient visitors to these shores—our Phœnician friends—that Nebuchadnezzar had repaired and dedicated it. Things repeat themselves after long cycles of years: that great king, instead of our solid granite used bricks, which he coated with enamel to preserve them. Now enamel seems to have been employed with success to shield the iron of ships from the action of sea-water; that problem, as far as relates to copper-sheathing, was solved by your illustrious fellow-citizen Sir Humphry Davy, in working out a highly ingenious theory.

Geologists may talk of the fall of Babylon as Botanists do of the siege of Troy, with which some of them, including Humboldt, believe some of the giant-trees of the forest were contemporary. Geologists *trifle* with time as the Chancellor plays with millions in the exchequer; to them a thousand centuries seem as a day. You must therefore not be surprised if this structure has until now

arisen *only* as an exhalation, like the vapour of the mirage which I have seen in the desert, where water and trees and many pleasant things dance before the eyes of the thirsty weary traveller.

To Sir Charles Lemon we are much indebted that the mirage is becoming a substantial reality. The Mayor has alluded to the many obstacles which had existed in bringing the subject of the whole structure to a practical conclusion. There could not fail to be difficulties where different bodies had various objects to be accomplished. It is probably the first instance in the kingdom that three foundation-stones for one harmonious building, with different purposes in view, has been laid on one occasion; *Tria juncta in uno*, it embodies the beautiful Cornish motto, "One and All."

I was long guiltless of building anything of greater pretence than a Lodge or a School. Houses for luxury or ostentation may serve to glorify the idea of self, but are of little worth. It is a very different thing when architecture is employed in the cause of Law, Charity, Education, or Religion. The palace of Nero is a ruin, but the Coptic church of *old* Cairo and the once pagan Pantheon at Rome are still devoted to religious purposes, and in the modest dwelling of the Bard of Avon is celebrated to-day his tercentenary commemoration.

A gifted writer on Art, after visiting the ruined palace of a most luxurious Cardinal, says that it is "desolate as it deserves—desolate in that worst of bitterest abandonment that leaves no light of memory. Thus," he adds, "end all the acts of life only in death, and thus issue all the gifts of man only in his dishonour when pursued or possessed in the service of pleasure only."

There is this satisfaction in the work before us, that it is designed for the public good and to supply a public want. Limited means and the necessity of union for mutual aid, combine in obliging us to modify the internal arrangements as well as the exterior. The ancients, without glass, and seeking shade, were little hampered by windows. Their great temples were often as open courts, and in their dwellings external openings were avoided, as now in the Bank of England and in Newgate (said to be a model of its kind), which "opes its ponderous and marble jaws" that the doomed criminal

may see for a moment the blessed light and then drop into eternity. Museums were at one time useless, for, without glass to protect them from atmospheric influences, objects would soon be destroyed.—In the dry climate of Egypt it was possible. The earliest museum on record was founded there by the far-sighted Alexander the Great. In it Aristotle may have placed the fruits of his dredging in the Egean Sea, for which the king had presented him with an enormous sum. Light is so essential here, that with all our love of our ancestors, your architect could not follow the example of the Greeks who would not depart from the model of the wooden hut of Pelasgus in Arcadia, that their claim to the soil as aborigines might never be forgotten; he could not safely copy the dwellings of the British inhabitants of Bosullow or Chyoster. The absence of caves in our granite and slate rocks, except at the sea-level, deprives us of their flint implements and of skeletons of contemporary animals. I doubt not, when you have space, you will be enriched by some of the remains of both kinds. Hitherto we have been like a miser exhibiting but few of his treasures, and then as if by stealth. To make due arrangements for this we hope, by liberality from all classes, to raise the fund from £2,200 in hand (or promised) to £2,600.—I say all classes, for the agriculturist, the skilled artisan, the miner, and the fisherman have a vested interest in Geology. The rocks on which the soil of these environs rests affect its rich produce, and the abundant mineral-veins of this County are associated with certain strata. This fair climate itself depends on the relations of land and sea. But these conditions of your prosperity are more constant than those of the fisherman's success. Did time admit, numerous illustrations might be given of these:—the formation of new or the removal of old sand-banks—the rising of the land—rivers forming new channels, or being silted up; all make themselves felt by him: the existence of pilchards, codfish, mackerel, &c., is probably dependent on certain banks, and on the currents of which the coasts of the Atlantic, and the mountains and valleys under it, determine the final direction.

The thousand enterprising and courageous fishermen who people this Bay have seen some of their boats sail for the antipodes, and

have reverenced the devotedness of others of their fellows, who, for the Gospel's sake, suffered almost a martyr's death in the sea-beat caves of Tierra del Fuego. They sail out of the Bay over an ancient forest on which lies the smooth sand, and lay their boulters or shoot the sean; then they cross part of the warm gulf-stream full of ocean life, to the shore of Ireland, which they supply with her own fish, and so on by the stormy Hebrides, through the great Caledonian valley of which Loch Linhe is but the gate-way; further north to Wick; and then, returning south, and ever fishing, reach the coast of Yorkshire. As a double portion of manna before the Sabbath was gathered by the Israelites, so these fishermen religiously observe the day of rest; and the people of Whitby say that they catch an extra quantity of fish on the working-days.—Then on by the chalk-cliffs of Flamborough Head, where a sailor told me that every smuggling-boat had been replaced by a fishing-boat; in sight of the shore of Holdernesse, which the sea is ever devouring; over the Yarmouth Sands, and through the English Channel; till at length the circumnavigating little fleet doubles the Lizard; and, as the "vision of the Guarded Mount" opens before them and they see their happy homes nestling in the cliffs, and the western hills all aglow with the setting sun (as it may one day also gild your beautiful cornice), they feel that they dwell in a South land, and can unite in the spirit of the prayer that has been offered, with thankful hearts to Him, by Whom and for Whom all things were created—their loving and ever-living Lord.

ROYAL

Geological Society of Cornwall.

FIFTY-FIRST

ANNUAL REPORT

OF THE COUNCIL,

WTH

THE PRESIDENT'S ADDRESS,

AND

PAPERS AND NOTICES

READ TO THE SOCIETY.

PENZANCE:

PRINTED BY W. CORNISH BOOKSELLER AND STATIONER.

—

1864.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness.

Her Most Gracious Majesty the QUEEN.

Vice-Patron.

His Royal Highness the Prince of Wales, K.G.

OFFICERS AND COUNCIL FOR THE YEAR 1864.

President.

Charles Fox, Esq.

Vice-Presidents.

J. F. Bassett, Esq.
William Coulson, Esq.
D. P. Le Grice, Esq., M.A.
J. St. Aubyn, Esq., M.P.

Treasurer.

William Bolitho, Jun., Esq.

Secretary.

S. Higgs, Jun., Esq., F.G.S., F.S.A.

Librarian.

Edward Hearle Rodd, Esq.

Council.

F. Boase, Esq.
Edward Bolitho, Esq.
T. B. Bolitho, Esq.
R. Davey, Esq., M.P., F.G.S.
H. Davy, Esq., M.D.
John S. Enys, Esq., F.G.S.
Samuel Higgs, Esq.
H. Paull, Esq., M.P.
Rev. M. N. Peters.
J. Jope Rogers, Esq., M.P.
J. Roscorla, Esq.
R. Taylor, Esq., F.G.S.

PRESIDENT'S ADDRESS.

It was a subject of regret to myself and many others that your late accomplished president relinquished the office he had filled so ably. I accepted the post to which your Council did me the honour of electing me, feeling that I am but a tyro in the science which is the special object of your pursuit. For, although it always had its attractions for me, whether at home or abroad, my experience convinces me that nothing will supply the place of that unremitting and close observation of geological phenomena in which I am so wanting, and, therefore, I must beg your indulgence for my deficiencies.

Since our last Annual Meeting we have had to lament the death of several of our members. Roland A. G. Davies, who took a great interest in the various arrangements for the erection of a building which might provide for the carrying out of local and general objects, was removed from us in the full tide of his energies and valuable services; and within a few days one of our oldest members, Stephen Davey, who often served in your Council and also as vice-president, has been taken from us at the conclusion of an honorable and useful life, at an advanced age.

It is not necessary for me now to enter into detail as to the progress of the museum. Many of you have seen that the walls are in part raised from six to ten feet above the level of the ground floor. The architect informs me that there has been a delay in the supply of dressed granite, but he trusts that it will be completed within the period of the contract. The report will show the state of the building-fund. Having recently visited two new geological museums—one at Milan, and the other that at the School of Mines in Paris—my impression is that this will be better lighted than

the Milanese, but not so perfectly as the splendid gallery of Paris, where windows on opposite sides enable one to see distinctly both the colour and texture of the specimens And whilst I remember with satisfaction the series of our crystalline and metamorphic rocks presented by Henry Boase, I found it difficult to turn away in Paris from a similar series of great extent, so highly instructive as illustrating their innumerable lithological as well as their mineral characters. When the collection in this room can be transferred to the new museum, the gaps in the series of this Danmonium region will be more apparent, as well as the absence of characteristic specimens of some of the overlying formations both at home and abroad. But, as a school-inspector questions the children about the streams and hills of their own parish, and leaves the Andes and the Wolga to more ambitious minds, so should it be our primary business to present to the eye an exhaustive illustration of our provincial geology. We must first study what Professor Phillips well calls "the most certain local truths," and construe them cautiously and philosophically before we can transfer them to large areas, and use them as the bases of general conclusions.

Professor Haughton's report on the granites of Donegal shows how chemistry, mineralogy, and mathematics are brought to bear on the characteristics of this rock, which occupies so large a place in this country and in the earth's crust generally. Of the fifteen granites examined, nearly half are not altogether composed of the quartz orthoclase and cligoclase and black mica that are found in them in distinct crystals, and he concludes that the remaining varieties even if composed of those minerals, must have a paste composed of the same minerals, but with a slightly different composition from the separate crystals.

It is not unworthy of note, as affecting the productiveness of soils, that the orthoclase felspar contains nearly seven times as much potash as the oligoclase. The quantity of lime in those granites varies from one to five per cent., and the potash from seven to two per cent. The associated syenites appear to form great bedded masses rudely stratified like the granites: they contain much more lime, iron, and magnesia. In the proximity of the granite, lime-

stone is converted into marble, as I have observed it in Tuscany near the eruptive rocks.

Sterry Hunt thinks the crystalline minerals of the metamorphosed rocks may indicate relative age and succession; the soda (or oligoclase) felspar is reduced to a hydrous silicate of alumina before the potash felspar, and that in the aqueous partial destruction of the primitive rocks quartz is much wanting in those containing a large proportion of alumina, but abundant where the potash felspar predominates; and moreover, that the relative proportions of alumina and alkalies in clay will depend on the number of times these materials have been broken up and on the periods of action of filtrating water. Dr. Zirkel's microscopic examination of granite (following in Sorby's path) finds in all granitic, porphyritic, and trachytic quartz innumerable very minute cavities containing liquids. The quartz includes myriads of crystals of vitreous felspar. Dr. Zirkel thinks that in them we can trace the simultaneous action of water, vapour, and igneous fusion.

I retain a strong impression of the unpretending bearing of Dr. W. Smith, who read in the oolites of Bath, in their right order, three letters of the geological alphabet before others were known. Like Sir H. Rawlinson, who deciphered a few characters in the rock inscriptions of Behistan, and thus at length disclosed the secrets of history, so has W. Smith's method unveiled the records of the immeasurable past. It was natural that, following on his track, observers should go on indefatigably investigating the fossiliferous beds both above and below his horizon, but long limiting their researches downward by the old red sandstone. Assent could not be refused to the main deductions from these "medals of creation" bearing the stamp of the Supreme mint, and more varied and graceful than the productions of Greek art. It was an unlooked for fact to find, that, of numerous species in the chalk, lias, and mountain limestone respectively, not one was found in two of these rocks. But deeper than the old red sandstone are found the remains of early life through the whole of the Silurian system. Far down in the so called primordial zone, the Lingula flags (lying on the Cambrian) J. W. Salter has found in abundance the gigantic trilo-

bite *Paradoxides Davidis*, with several new species of trilobites, as well as a new sponge—an organism not before found in that zone. The survey of Canada has discovered metamorphic rocks of enormous thickness (lower than the Silurian) in crystalline masses of gneiss, schist, quartz rock, and granite, &c., then wasted down to form the pebble beds, sandstones, and shales of the lower Silurian. Sir R. Murchison has classed with the Laurentian rocks the fundamental gneiss of the western shores of Ross and Sutherland and the outer Hebrides, both containing beds of limestone: previously, the underlying Cambrian were supposed to be the oldest sedimentary rocks. Dr. Rubidge has observed in the south-eastern counties of Maine that granite overlies strata of gneiss and mica schist, and Dr. Hitchcock has noticed a similar intermixture of granite in York, Oxford, and Cumberland counties.

Many of us have long been convinced that our Danmonian region needs a more complete survey and new mapping. Professor Ramsay presses this point, and observes that it is at present impossible to say what nonconformities exist in the series, or to mark out accurately the exact zoological relations of the subdivisions, and that it cannot be proved that the lowest Devonian rocks exist in Devon and Cornwall. He agrees with J. W. Salter that the Devonian fossils are distinct from those of the lower Silurian rocks, on which in Cornwall they rest unconformably, for, out of many hundreds even of upper Silurian forms, only about six are found in the lower Devonian. Happily, those Silurian rocks are no longer massed together, thrown like foundlings into the hospital of the old red sandstone, from which many geologists of note would take them out, and place some in the Silurian and others in the carboniferous families.

If, in the arrangement of sedimentary strata, the letters of the alphabet were all used up and figures had to be employed as the necessity for further division was discovered, so has it also been found that successive beds distinguished by these letters must have been widely separated in time, as elsewhere whole groups of letters, or the formations to which they were attached, were missing. Of the former, Professor Ramsay gives frequent illustrations on the physical breaks (or nonconformities) repeated ten times between the

Laurentian gneiss and the Permian strata, accompanied by sudden and remarkable change of fossils, sometimes in the genera, always in the species, and he connected these organic interruptions with the breaks in the strata; and as to missing deposits Dr. Bigsby has summed up very many instances of it. In Scandinavia, diluvium and drift lie on Huronian or Laurentian rocks. For two thousand miles through Labrador and Canada no mesozoic nor old tertiary rocks have been met with. It is noteworthy that in Wisconsin, an area of three thousand square miles, marked by the absence of drift, is that of the productive lead district which J. W. Whitney thinks has never been overflowed since the upper Silurian epoch. Near Cordova, miocene is horizontally incumbent on inclined carboniferous strata. Large portions of the Ural mountains have no deposit between the drift and the carboniferous strata. Near Bleiberg is a series of gaps, from the absence of chalk, oolite, Permian, Devonian, &c. Viscount Archiac has tabulated seventy-one regions in which little more than one-third of all the subdivisions of the cretaceous series has been acutally laid down. In England this series is unconformable with the oolitic. In the Sierra de Guadaramma, chalk rests on granite, and on gneiss and mica slate in seven other districts. Captain Godwin Austin states that the nummulite limestone rests on the rocks (perhaps Cambrian) of the Pir Pinjal mountain flanking the valley of Cashmere, without the intermediate Palæozoic and mesozoic series.

Whilst most diligent and accurate observers were gradually accumulating details of various geological formations, startling discoveries from time to time directed popular attention to the new science. Some of us may remember, long after the surprise at Cuvier's finding extinct *Palæotheria* in the quarries of Montmartre, and his skill in reconstructing their skeletons and determining their habits, how great was the excitement at the marine and the winged reptiles in the oolite and the lias, some of the latter with enormous teeth, and with wings, as Owen estimates, of twenty-two feet from tip to tip. The footprints of other reptiles and gigantic birds in sandstone; the *Dinosaurians*, or crocodile lizards, with their hollow bones, from the Stonesfield oolite or the Wealden; the *Batrachiai*

labyrinthodon, from the new red sandstone; the bulky *Edentata* of the Pampas; the armed cartilaginous fishes which H. Miller disinterred in the old red sandstone, supposed (until C. W. Peach's discovery) to have had no osseous fishes associated with them; the organic remains of the primordial zone, marsupials from the Purbeck and Stonesfield beds, and one (a *Microlestes*) discovered by C. Moore in the Rhœtian beds of the Frome limestone, and subsequently W. B. Dawkin's specimen of a kangaroo rat, the earliest known fossil mammal, and, as W. B. Dawkins adds, these are scraps amid fossil *Zamiæ* and *Cycadeæ* and *Cestracionts* and *Tregonea*, which now flourish in the area of the existing marsupials, representing one-third of the latter; add their mighty congeners which once inhabited Australia, and lastly, that anomalous bird of the Solenhofen slate; the gauging of the Atlantic, disclosing its high mountains and deep valleys (an enquiry which the Government is likely to pursue), confirming La Place's deductions from the theory of the tides: all these were so many salient points to attract even the unobserving eye.

The occurrence of an unexpected form sometimes unsettles geologists in their scale of strata. The air-breathing crocodilian *Steganopsis* in the sandstones north of Elgin led to doubts as to the Palæozoic age of the bed in Northern Scotland which contains reptilian remains, and to lift them to the triassic. The footprints of reptiles in Rosshire seemed to strengthen this idea, as it had been held that no animal had breathed air before or during the deposition of the carboniferous measures. But those in America, Bavaria, and England include reptiles, mostly *Labyrinthodonts*. Professer Huxley considers that in the British two very distinet types are united,—the *Archegosauria* of the carboniferous rocks, and the *Mastodonsauria* of the triassic age. Professor Harkness, after a careful survey of all the conditions of the Elgin sandstones, concludes that they are old red.

When young I was turned into the Port Royal "Jardin des Racines Grecques," the garden of Greek roots, rhythmically arranged. One may now study them, and the comparative anatomy of all the Dons in a geological museum. Formerly men indulged

in innumerable hypotheses to account for the structure of the earth; the present age has been diligent in accumulating facts, but few could avoid theorising on their mutual relations. The piercing or uplifting of sedimentary rocks by igneous ones, and the metamorphic state of others, vast vaults which did not affect the surface planes; the great number of these discovered in accurate surveys, as in that of Wales, where nearly twelve hundred, from one-half mile to one hundred and eighty miles in length, were mapped; the comparatively recent elevation of land, as in a district which I have seen in Sweden, where barnacles remain attached to gneiss rocks far above the sea; the grinding of rocks by ancient glaciers, and their moraines, leagues in length; the transfer to a great distance of enormous blocks, on one of which I saw the garden and summer-house of an eccentric Englishman; thousands of square miles of drift or of denudation to a great depth; the sinking or rising of islands, or even continents; the formation of coral islands;—all formed an ample field for speculation. Sir C. Lyell believes that these phenomena can be accounted for by the continuous action of causes now operating, and that the disturbing internal forces are felt in irregular succession beneath all the points of the surface of the globe. Professor Phillips says, that for this system, "the postulate required, is unlimited duration, but on the other a varying momentum of natural agencies according to differences of condition, and, that nature offers to our view examples of both these cases, and on a large scale." He would "compare always the ancient phenomena with the most similar discoverable effects of forces now in action, and not forget that in earlier nature, as at present, the combinations of phenomena varied; and the measures of effect were modified accordingly."

If we would learn to note local facts, and from them to infer the order of occurrence of disturbing forces, we should study William Pengelly's Cabinet Picture of the shores of Torbay, in which he has restored some of the features of its youth, from the more winning lineaments of the aged present. Coralline limestone cliffs (some two hundred and eighty feet in height) give evidence of ancient wave-action, with platforms varying in height and pierced by litho-

domous shells (some a mile from the sea); caverns containing undissevered bones of extinct animals, with some recent bones, and flints probably worked by man, resting on a bed of gravel, on the same level as that in the valley of the Teign, one hundred feet above high-water; white clay on the gravel containing roots and leaves, the latter of *Betula nana*, which I have often admired in arctic regions; raised beaches, having shells identical with those of the bay, twenty feet above the sea; a submerged forest extending under the sea, and resting on sand containing marine shells of recent species; a seventy-five-feet high terrace of old red sandstone: from these and other facts he seems to have developed and to present clearly to the mind the extent and sequence of the various movements in the district, whether of subsidence or of upheaval.

How small and yet how certain may geological evidence sometimes be! The study of insect life near Para led that most diligent and successful naturalist, W. H. Bates, to confirm Von Martius's suggestion as to the state of the delta of the Amazon. Why should not the forest south of that river, and extending for nearly one thousand miles, have a Brazilian fauna, whereas among two hundred and four delta species of insects he found only eight Brazilian forms, whilst there are thirteen times as many having affinities with those of Guiana, from which they are separated by a wide expanse of water impassable to this class of forest species? Looking at these facts, and at the rocky foundation of the delta, he concludes that there was an ancient chain of islands bridging over from Guiana to the south side of the Amazon. And it may be added that the flora, as well as the fauna of Guiana and Brazil, to the north and south of the Para district, represents two distinct provinces, each region having a very large number of forms peculiar to itself. Each has a nucleus of elevated table-land. If the whole expanse were now engulphed and fossilised, on the same horizon might be found genera so distinct as to class the two districts as geological formations of different eras, enclosing eight hundred new species of fishes not discovered elsewhere, and marine animals five hundred miles from the ocean. If I may add another illustration, I would say, that, standing on the edge of the vast Lybian desert, and handling a

nummulite of the foraminiferous rhisopods, one could not resist the conclusion that the trackless sands once formed an ocean bed. Geologists have shewn that there could have been no föhn or hot south wind which melts the snow and glaciers of the Alps faster than the direct rays of the sun, if it had passed over water instead of being heated by the sand, and that thus the glacial condition of the north hemisphere might have been induced. Aristotle, who saw in the "unity of nature nothing unconnected or put out of place as in a bad tragedy," could not have anticipated that in the present day Dr. Barth would have found a blind Arab keeping as a precious treasure an Arabic translation of that great naturalist. The varying eccentricity of the earth's orbit may have heightened these glacial effects. But the aphelion of the earth during our winter and its greatest distance from the sun have not coincided within one hundred thousand years. Professor Phillips quotes the observation of a German mathematician, named Adhemar, that our Northern hemisphere has now the advantages of position and a higher mean annual temperature depending on the inequality of the half-yearly periods, and concludes that within each tropical period of ten thousand five hundred years snows would gather round our pole to be afterwards melted and form deluges. C. Darwin's discovery of animals and plants in Patagonia, and in the circumjacent ocean, belonging to a warmer zone, would indicate that the mean temperature there has been higher. If modern research has carried us into deeper zones of life, it has also been busy in man's present horizon, exploring gravel, osseous breccia, and caverns, and throwing fresh light on extinct or recent mammalia, associated as many of them are with the works of man, whether by currents, by floods, or by subsequent human occupation, it is not always possible to determine. The flint implements from the valley of the Somme, which I have placed on the table, bear marks of design, but whilst some geologists will not assign to this deposit of gravel any lengthened period, it cannot be said that a general conclusion respecting it has been arrived at. There are more definite data in the osseous breccia of the Dordogne and the Pyrenees, such as those described by Lartet and Christy, in the memoir which the latter gentlemen wishes me

to present to you, intending to follow it with some of the breccia found either in caves or under overhanging rocks having a south aspect. Bones of the horse, reindeer, &c., mixed with flint implements and other works of man, such as rude carving, are clearly made out. Cuvier was surprised at reindeer bones being found in breccia in the Department de Lot. But the snows and glaciers of the Pyrenees would still be congenial to them at the present day, and H. Christy told me that he plucked a reindeer lichen near one of the caves. Amongst the stone implements, of which that gentleman possesses perhaps the finest collection, there is one universal form still used by uncivilised man as it was by those ancient races—that is, the ring of stone, of bone, or metal, which encloses the thread while spinning. He possesses from the extinct colony of East Greenland remains of their implements: as their iron diminished, when the communication with Europe ceased, it was reduced first to a cutting edge, then to a mere point in bone, and, lastly flint was substituted.

It appears to me that deductions as to race from isolated human skulls must be made with great caution. J. W. Bates found that the shape of the head was not at all similar in any two out of ten Arcoma Indians living on the Upper Amazon. He makes similar observations on some of the Brazilian tribes. We are proud of our cromlechs, which, however, yield us no certain traces of the race which constructed them; possibly, light might be derived from the very large number visited, if not discovered, by H. Christy and a French gentleman, thirty miles S.E. of Oran in Algeria, placed on a shaly limestone rock, on which the scanty soil was heaped to cover the dead. They explored eighteen, and under each found one—sometimes two—skeletons. Of the crania or implements I have had no details, but it is certain that in one cromlech was a coin of one of the Empresses Faustina. Dr. Tate, in 1861, in one of the trilithons of Stonehenge, discovered the letters L V partly surrounded by a hooked figure.

Your late very able president touched last year on the theory of the accomplished Darwin, which may have this slight foundation for it, that accidental varieties of hybrids may, under new circum-

stances of food or climate, become specific, if not generic. This may especially apply to plants having a compound life and several modes of reproduction; but the deeper we go into the immeasurable past of Palæozoic strata we approach no nearer to any universal type of animal or vegetable life, without speaking of the briozoa of the Laurentian gneiss, on which the foraminifera of the present day seem to have made no advance. We see that the trilobites of the lowest Silurian, although found by J. W. Salter to be inferior in organization to those of newer strata, are anything but rudimentary forms; one living analogous genus, the *Limulus* (having a less range of vision than the *Asaphus candatus*, with its beautiful lenses), has two stemmata or small eyes in front. Professor Harkness says that the forms of those graptolites which are earliest in time are of the most complicated design. L. Dillwyn has well observed that the testaceous carnivorous cephalopods existing before the tertiary strata seemed to have discharged the same duties as the carnivorous univalves in the tertiary strata. The belemnites, that large extinct class of cephalopods, so abundant in the secondary strata, have affinities with three living genera. Those families of them which were not protected by shells, but had soft bodies, were furnished with ink-bags, from which, like anonymous writers, they blackened their adversaries. Muschekalk fossils, two hundred and twenty-two in number, are of secondary type, and yet those of the St. Cassian beds which lie above them have a Palæozoic type, in one-seventh of the genera, and one-fifth of the species. If there were ten enormous gaps both in the strata and fossils between the Laurentian and the Permian rocks, what was become of the chain of life between them? On Hume's theory, no evidence could prove the existence of an animal like the duck-bill *Platypus*, because contrary to the order of nature. The Herald's college of geology finds no coat of its ancestors' arms recorded in any rock with its quarterings of bird, beast, or reptile, and icthyosaurian sternum.

We have recently seen a skilled advocate fencing with one fact, which told against his client; a second fact strengthened the first, and the third made the evidence irresistible; but if we take the smallest work of nature we shall find, as Gœthe says, "its circle of

completeness within itself." Look at the spider—balancing on its delicate web with telegraph wires to the centre; its small tooth-comb, for keeping its threads distinct; the innumerable spinnerets of its fairy strands; the poisoned fangs which may kill, without endangering its net by a struggle; numerous eyes to detect the best point d'appui for its web—are surely irrefragable evidences of design, not coincidents culminating in one point after the lapse of ages. Whence came the special electrical organs of the otherwise helpless torpedo, the analogue of which is found in a remote class of fishes? By what wise selection did the human eye, from its refractive powers, command ten-eighteenths of the circle of the horizon? A poor woman in a London garret liked to have a strawberry plant in her window "because," as she said, "It tells me that God is near." Shall we, the more that we look into the wonders of the past, doubt this present and ever enduring truth? Is it more surprising that He should create in different epochs of time than in different points of space? In this crust of our earth, as yet but partially explored by geologists, there is still a vast field requiring accurate observation, the aid of every department of science, and the most careful logical deduction from facts, and above all, a reverent spirit towards Him who "made all these things."

THE FIFTY-FIRST ANNUAL REPORT OF THE COUNCIL.

THE Council, on handing the fifty-first annual report to the Society, have to congratulate it on the realization of that long-cherished scheme—the commencement of the building of a Museum worthy of its collection and its founders. As this desirable event has been brought about, through considerable difficulties and under peculiar circumstances, the Council deem it necessary to lay before you an account of their stewardship since their appointment on the 23rd of September, 1863.

In consequence of certain communications received by the acting secretary from the Penzance Town Council and the Directors of the Penzance Public Buildings, on the 1st of November, 1863, it was thought expedient by the resident members of this Council to convene a meeting to consider them; notice of which was duly sent to the president, vice-presidents, the members of the Council, and officers. This notice led to certain correspondence from the then president, Augustus Smith, Esq., followed shortly by a request from him that a special general meeting of the Society should be convened for the purpose of relieving him from the office of president by the election of some one else as his successor; this meeting was called on the 27th of November, by circular and advertisement, at which Mr. Smith's resignation was accepted, and Charles Fox, Esq., elected president.

On the 24th of December the Council, having carefully examined the finances of the Society, considered they were in a position to proceed to tender. Other matters of detail were discussed, but in the absence of the president a copy of the proceedings was forwarded to him, with a wish that he would cause a special meeting to be called to confirm the same. The 21st of January, of this year, was

appointed, and the resolutions of the previous meeting were confirmed and the specifications of the new building examined.

As this matter was of such vital importance to the Society, and, the president wishing to ascertain the views of other members, it was thought expedient to convene a special general meeting on the 2nd of February, At their meeting the resolutions of the Council were again confirmed and the advertisement for tenders authorized.

On the 28th of March, the Building committees met to receive the tenders, and accepted that of Messrs. Olver and Sons, of Falmouth, to complete the building of the Geological Museum for the sum of £2,500, subject to a schedule of prices on which work might be either added or withdrawn. But as this amount, including the sum of £118 for extras, exceeded the sum authorized by the Society to be expended on the building by £400, the Council re-examined the specifications and were enabled to effect a saving of £360, by postponing the fitting-up of the basement-floor and sundry embellishments of the rooms.

On the 31st of March the tender was formally accepted and arrangements made for laying the foundation-stone. This was done by the president on the 27th of April. At the same time, the foundation-stone of the new Town Hall was laid by the then mayor (the late R. A. G. Davies, Esq.), and that of the Penzance Public Buildings by the High Sheriff of Cornwall, D. Perry Le Grice, Esq.

The building progresses favourably, and there seems every reason at present to suppose that it will be completed within the specified time of two years and four months.

The Council beg to call attention to the Treasurer's report, from which it will be found that a further sum of £500 will be required, and would earnestly impress upon all friends of the Society the necessity of making a strenuous effort to collect funds sufficient to enable it to enter the new building without a debt.

The contributions to the Museum during the past year are numerous and interesting.

Mr. Henwood reports that the eighth volume of *Transactions*, which is to consist of observations on metalliferous deposits only, has reached its 338th page, and will be finished within two years.

The 48th, 49th, and 50th annual Reports will be ready for distribution in four weeks, and will complete the seventh volume.

The only matter of scientific importance in connection with Cornwall this year has been the discussion at the meeting of the British Association at Bath on hot mineral springs. As this subject is far from being exhausted, the Council beg to call especial reference thereto, and to express a hope that notices of such phenomena may be sent to this Society, and thus maintain the high encomium passed on the value of our *Transactions* by Sir Charles Lyell.

Attention has again been called to the Society's rules, which certainly are meagre in the extreme. A code of rules was submitted to the Council by William Coulson, Esq., one of our vice-presidents, when a sub-Committee was appointed to consider the subject, and the following resolution was passed:—

"That this meeting is sensible of the interest manifested by Mr. Coulson in the welfare of the Society, and, whilst they take this opportunity of stating that they have no power to suggest any alteration of the rules, they cannot refrain from expressing an opinion that a revised code of laws for the future government of the Society is desirable; and that the rules prepared by Mr. Coulson might, without difficulty, be modified to meet the requirements of the Society."

We recommend that the Council for the ensuing year be empowered to frame a new code of laws, to be submitted for approval at the next general meeting, and would suggest special attention that clauses may be inserted to facilitate exchanges of specimens with kindred Societies, and also that—on application, and under proper restrictions—the Scientific Associations and Societies of Cornwall may have the privilege of the use of the museum for the purpose of study, and facilitating their researches.

In concluding this Report your Council—whilst again congratulating the Society on the commencement of its new Building—have the mournful duty of recording the deaths of six of its members, all of whom took a lively interest in the welfare of the Society.

The Council will not be out of place in here recording their mark of respect to the late Mayor of this town, R. A. G. Davies, Esq.

Two others were members of the Council:—one bade fair to uphold in the science of Geology the well-known name of Carne.

Mr. William Richards, of Redruth, not only this year, but on many previous occasions, has been a member of your Council.

Mr. George Higgs; Mr. Stephen Davey, of Redruth, who more than once held the office of vice-president; and Mr. John Garby, of Redruth, complete the sad list.

By order,

SAML. HIGGS, JUN.,

Secretary.

November 25th, 1864.

DONATIONS TO THE MUSEUM.

1. A valuable collection of Minerals and Fossils from Iron Bark, Sandhurst, Australia. By Mr. W. Nicholas, through Mr. J. J. Lanyon.
2. A curious specimen of Tin and Chlorite, from *New Rosewarne*, near Camborne. By John Rule, Esq., Ordinary Member of the Society.
3. A Fossil, *Posidonia lateralis*, from *Wheal Hamblyn*, Bridestowe. By Richard Pearse, Esq.
4. Tufa and Marble, from Matlock, Derbyshire. By Mr. John Murphy.
5. Flint Implements, from the valley of the Somme. By Charles Fox, Esq., President of the Society.
6. Osseous Breccia, from the Dordogne and the Pyrenees. By Dr. H. Christy.

DONATIONS TO THE LIBRARY.

1. Journal of the Boston Society of Natural History, Vol. VII., Part 4, with several Numbers. From the Society.
2. Smithsonian Contributions to Knowledge, Vol. XIII.; Report, 1862; Miscellaneous Collections, Vol. V.; Catalogue of Minerals. From the Society, at Washington.
3. Annual Report of the Trustees of the Museum of Comparative Anatomy, 1863.
4. Proceedings of the American Philosophical Society, Vol. IX., No. 70. By the Society.

TREASURERS' ACCOUNT.

INCOME.	£	s.	d.
Balance Petty Cash	3	16	1
Subscription from His Royal Highness the Prince of Wales	20	0	0
Subscriptions from ordinary members and arrears	92	14	0
Rent of Gentlemen's News Room	7	7	0
Balance due to Treasurer	16	0	8
	£139	17	9

EXPENDITURE.	£	s.	d.
Balance from 1863	41	12	3
Rents, Rates, and Taxes	45	10	6
Housekeeper, &c.	7	2	0
Coal and Repairs	3	7	0
Insurance	3	3	6
Printing, Stationery, Advertising, &c.	25	3	2
Coins for Foundation-stone	1	14	9
Subscription to Palæontographical Society	3	3	0
Expenses per Secretary and Treasurer	4	14	6
Balance Petty Cash in hand	4	7	1
	£139	17	9

ROYAL

Geological Society of Cornwall.

FIFTY-SECOND

ANNUAL REPORT

OF THE COUNCIL,

WTH

THE PRESIDENT'S ADDRESS,

AND

PAPERS AND NOTICES

READ TO THE SOCIETY.

PENZANCE:

PRINTED BY W. CORNISH BOOKSELLER AND STATIONER.

—

1865.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness.

Her Most Gracious Majesty the QUEEN.

Vice-Patron.

His Royal Highness the Prince of Wales, K.G.

OFFICERS AND COUNCIL FOR THE YEAR 18~~6~~5.

President.

Charles Fox, Esq.

Vice-Presidents.

Edward Bolitho, Esq.
John S. Enys, Esq., F.G.S.
D. P. Le Grice, Esq., M.A.
John Rule, Esq.

Treasurer.

William Bolitho, Jun., Esq.

Secretary.

S. Higgs, Jun., Esq., F.G.S., F.S.A.

Librarian.

Edward Hearle Rodd, Esq.

Council.

F. Boase, Esq.
Samuel Borlase, Esq.
William Coulson, Esq.
R. Davey, Esq., M.P., F.G.S.
G. M. Millett-Davis, Esq.
Samuel Higgs, Esq.
Rev. M. N. Peters.
J. Jope Rogers, Esq., M.P.
G. Smith, Esq., LL.D. F.S.A.
J. St. Aubyn, Esq., M.P.
W. Teague, Esq.
George Williams, Esq.

PRESIDENT'S ADDRESS.

If the Society has done but little since our last annual meeting in examining our strata geologically, you will learn from the Report about to be presented to you that progress has been made in breaking some of them up and building them together in a definite form, to which we confidently hope that those great men who study mother earth so critically, and point out her various faults and blanks in the series of her arrangements, will give their approval, and aid and stimulate us in a manner worthy of the high patronage accorded to us and of the name which we bear.

The Journals of the London Geological Society, the annual Address of its president, and the Papers communicated at the recent Meeting of the British Association, contain many details of local researches, and epitomes of able and useful works from the pens of leading geologists abroad.—M. Barrande, on the development of the 2nd and 3rd Silurian fauna in France, as well as in Bohemia and Spain; Dr. Waagen, of Munich, on the Jura formation in Franconia, Swabia, and Switzerland; Professor Credner, on the Geology of N.W. Germany, are amongst these. Greatly should I have valued, when on the Gulf of Spezia last year, such a geological map of that district as Chevalier Capellini has just published, representing important alterations in the classification of some beds. I have often admired the splendid spring of fresh water rising out of the sea near Marola; it induced the elder Napoleon to propose making a great naval establishment there. Chevalier Capellini says it rises between the Eocene, and apparently *overlying* Triassic, which are separated by a great fault.

Dr. Hartung thinks that the more recent volcanic rocks, attaining a thickness of five thousand feet in Madeira, have been raised since the marine tertiary deposits, containing two hundred species of

shells; some, recent ones of South Africa and the East Indies,—others, European, Miocene, and tenants of every zone, whether littoral or deep sea. In connection with this subject, it may be stated that of the seven species of Terebratulæ, found in the Miocene of the Maltese islands, four are still living in the Mediterranean.

Viscount D'Archiac, in his recently published second volume on Palæontological strata, has enlarged on the succession of the most ancient forms, down to the present day, as indicating a constant progress and a uniform plan, which cannot be the effect of chance.

Some read books for information, others to excite emotion or surprise; those who are beginning the study of geology will find, in Sir C. Lyell's new edition of its elements, those different charms in literature amply supplied. "The gorgons, hydras, and chimœras dire" of the Lias, or the monsters of the Wealden, may content those who love sensational horrors; and the wondrous store of information, much of it derived from the personal researches of a long life, and the skilful correlation of facts, leave a marvellous impression of what may be accomplished by one able and most industrious mind. Sir C. Lyell may see, in the changes disclosed by these facts, merely the gradual efforts of causes still in operation, whilst Sir R. Murchison contends that we must admit that great convulsions in nature have often taken place in pre-historic times. Happily, geologists are not sanguinary in their contests. A few foraminiferous small shot from Canada are quite sufficient to dethrone the dynasty of Barrande's primordial zone; to conquer, they shew not their own teeth, but those of a mammoth or a rhinoceros: the strongest entrenched position must surrender at the sight of two cross bones and a flint spear-head, and the contest, as to certain forms having been long extinct, has been settled by the monstrous but not explosive Dinornis egg-shell, found in the skeleton hands of a Maori on his grave. Did he, like the Egyptian, consider the egg as the emblem of immortality?

At our last year's meeting I alluded to the discovery of organic remains in the Laurentian rocks of Canada, which appear to have no equivalent in England or Ireland, but to be of the same formation as that Sir R. Murchison has named as the fundamental gneiss of

Scotland (where they have a strike nearly at right angles to that of the other strata). Sir W. Logan has recently published a notice of these supposed earliest forms of animal life, which have therefore been named Eozoa by Dr. Dawson, of Montreal, who, having made a minute examination of their structure, considers them (as does also Dr. Carpenter) to belong to the Foraminifera, of which some species form, with their shells, thick beds in the Atlantic.

Dr. Dawson does not consider it as an objection to this classification, that the great size and compact growth of these Rhizopods produces an impression (as Sir W. Logan says) that the general character of the rock connected with it is that of a great foraminiferal reef, but differing from more recent coral-reefs in the absence of shells, &c. Chemistry is rather the colleague than the handmaid of geology. As far back as 1858, Dr. Carpenter (?) maintained that the Laurentian beds afforded evidence, by their chemical characters, of the existence of organic life at the time of the deposition of those old crystalline rocks. Dr. Carpenter anticipates that this discovery of Eozoa is the precursor of many others to be made in this Laurentian series; there must have been co-existing other organisms, probably very minute, on which they fed.

The upper group of the Laurentian series rests unconformably on the lower. Their united thickness Sir W. Logan estimates at not less than 30,000 feet: we may add to these the 18,000 feet of the Huronian group (overlying the Lower Laurentian unconformably). These Huronian rocks support on their upturned edges the horizontal beds of the Lower Silurian. The (Grenville) limestone in the Lower Laurentian series form a zone of about 1,500 feet in thickness, at the base of which the Eozoa are formed, where serpentine and carbonate of lime alternate in parallel waving plates of a few inches in thickness. Dr. Sterry Hunt has pointed out that the calcareous skeleton of the Eozoon is generally unchanged; the sarcode or substance of the animal, even in the minutest tubuli, has been replaced by a silicate such as serpentine or white pyroxene; and he remarks that this formation of siliceous mineral face to face with life confirms his view expressed some years since, that they were due not to subsequent metamorphism, in deeply buried sediments,

but to reaction going on at the earth's surface. Dr. Carpenter calls our attention to the fact that a portion not larger than the smallest pin's head of the earliest fossil yet known should enable geologists to determine its relations to existing organisms. One little suspected when visiting, some thirty years ago, the beautiful calcareous serpentine of Connemara, that organic remains existed in it, or in that from the Hebrides, as appears to be made out (Dr. Dawson doubts the latter being an Eozoon). Professor Harkness observes that the serpentine of Connemara is not in the Laurentian but in the Silurian zones.

We must not be surprised that the researches of geologists, as they are extended in breadth and in depth should lead them to the discovery of strata differing in age from those above and below them, and needing to be distinguished by a definite name. Henry Hicks, in his researches in the Lingula flags, near St. David's, found in the lowest division trilobites of six or seven genera, brachiopod and pteropod shells, cystideæ and sponges, all of them distinct as to species, and usually as to genera also, from the overlying rocks of the Lingula flags, and indicating a period in which not even the genera common in the great Silurian deposits are to be found. Menevia, the ancient name of St. David's, is now attached to the formation revealing this ancient fauna, with which are associated beds of contemporaneous trap. At the recent Birmingham meeting, David Forbes read an important Paper on the igneous rocks of Staffordshire. He observed that in such investigations, the chemist, geologist, and minerologist should go hand in hand, and that the specimens to be examined microscopically also should be taken as deep down as possible. Analyses of these rocks from seven different localities of the thirteen bosses of igneous rocks, including the Rowley hills, showed that, however different these rocks might be in appearance and distinguished by different names by the miners, they were in reality one and the same rock. These Rowley hills, of two and a half square miles, often gave rise some thirty years ago, to discussions between a late relative and myself as to their destructive influence on the 10-yard coal which ought otherwise to be undisturbed under his adjoining land, where it is now worked.

Geology has since discovered that the great igneous boss issued through a fissure only eight feet wide. The microscope proves that these rocks are composed chiefly of soda, lime, felspar, a little augite, and titanium. It may be noticed, that a bed of iron-clay was found jointed into regular hexagonal columns, owing to the proximity of the igneous rock.

Sir R. Murchison, more than twenty years ago, encouraged Lord Dartmouth to persevere in sinking for coal near Christchurch, because he was persuaded that it would be found below the Permian sandstone. He reached the 10-yard coal at the depth of one hundred fathoms; it was horizontal and free from faults; whereas the coal-field (properly so called) was irregular from the penetration of Silurian and other rocks. Sir R. Murchison had no doubt that the South Staffordshire coal-field would be extended to the south and on both flanks. The deliberate judgement of so able a geologist qualifies Sir W. Armstrong's discouraging view as to the rapid exhaustion of our coal-fields.

One of your members, many years ago, had a correspondence with Sir Henry de la Beche as to coal not being wholly of vegetable origin; the copious supply of petroleum in North America has revived this opinion, now contended for by William Young and others. They are doubtless influenced by its arising from rocks below the coal-measure. Humboldt describes it as coming elsewhere from an immense depth through mica schist; some of the ten thousand salt-wells in China are three hundred fathoms deep; the mother-waters of the salt contains pale yellow petroleum. In Auvergne, some springs contain twenty per cent. of bitumen, and there the granite occasionally gives out a bituminous odour. In Dalmatia, bitumen is found to the extent of seven per cent. in a dolomitic rock. The bituminous springs, which are in fact scattered over the globe, produce as Lecoq says, the hydro-carburet, varying from pure naphtha to petroleum of different densities and colours, and to liquid and solid asphalte. The oil-springs of North America (some of which rise to the height of seven yards above the surface), producing daily a quantity equivalent to a large amount of coal, arise principally from the Devonian and Upper Silurian

rocks, which are supposed to extend from Upper Canada, below the carboniferous strata of Michigan, Ohio, and Pennsylvania.

The springs seem to be most abundant where the strata are inclined and dislocated, and some to contain fresh, others salt, water. The president of the London Geological Society quotes Lesly's account of a petroleum vein in North Western Virginia, "which is pure asphalte; it fills a crack several feet thick, and of great extent, cutting through the rocks of the country almost at right angles to their stratification. Its solidification must have taken place at a very early geological period."

The proportions of carbon and hydrogen in the bitumen of Idria are precisely the same as in some coal, the latter containing in addition about two per cent. of oxygen. Lecoq says that "Sterry Hunt's analysis proves that nature can produce the hydro-carburet, as she does the carbonic acid, in her vast laboratories with such temperature and pressure as we cannot command." Those who believe in the mineral origin of coal think that they see in the enormous supply of petroleum evidence that in ancient times it might have flowed in quantities sufficient at different epochs to form beds of coal, varying in thickness and in the proportions of their constituent elements, and enveloping the vegetation of the then existing surface, affecting least the stigmaria roots in the clay which in Wales underlie the Welsh coal, the organic remains of other plants being found in the roof. They call attention to the fact that in all American coal-strata there are numerous root-beds without any superincumbent coal. They enquire, why should a rich vegetation of at least five hundred species of plants growing through a vast epoch (as is supposed) be almost entirely destitute of remains of air-breathing animals, although a little insectivorous mammal (probably marsupial) has been found in a bed underlying the Chatham coal-field in North Carolina. Sir C. Lyell states that no land-shell has yet been met with in the coal-fields of Europe, nor until 1844 any contemporaneous air-breathing creatures. Dr. Dawson and he in 1852 discovered in the coal-measures of America the first osseous remains of a reptile in the trunk of an erect Sigillaria, two feet in diameter, of which the bark was converted into coal, and a Pupa,

the first land-shell ever met with in the coal, or in beds older than the Tertiary. Dr. Dawson has since found the same shell in abundance in a clay 7 feet thick, but 1,200 feet lower down than the first reptile, and eleven other species of air-breathing reptiles have since been met with either in Europe or in America. Well may Sir C. Lyell write, "that after all the researches we continue almost as much in the dark respecting the invertebrate air-breathers of this epoch as if the coal had been thrown down in mid-ocean. The contemporaneous seas swarmed with life. We must therefore collect more facts if we expect to solve a problem, which in the present state of science cannot but excite our wonder."

Your Transactions record some of the earliest exact experiments on the temperature of the earth as we descend into it, some of these having been among the very first made or communicated. The facts then disputed by many are now established, and the conclusions yet more widely impugned have been generally adopted. It was suggested that the high temperature observed in some mines was owing mainly to the ascent of hot water, or vapour, from great depths, varying in its effects according to the facility afforded in its passage upwards, and that as the solvent power of water increases with its temperature, which might be enormous at a great depth, mineral substances, especially silex, would thus be brought up through fissures, and deposited in the course of the descent through cooler portions of water. Modern chemistry, aided by spectral analysis, has shewn how varied and how numerous are the products of thermal springs. Lecoq (in the most comprehensive work on that subject that has appeared in geological literature) enumerates in mineral-springs twenty-two metals, including tin, silver, and gold, besides the gases, and chlorine, iodine, bromine, sodium, fluorine, sulphur, phosphorus, boron, carbon, and silicon, The well-known deposit of silex near the Geysers of Iceland, covering a space of two square miles, and, in some places, one hundred feet thick, is a familiar instance of silex, the product of thermal springs. One may see in the centre of France veins of quartz forming a crest, and in their immediate neighbourhood cementing the débris of other rocks. The vast vein of quartz near Gorran Haven, extending to the west, has

near it an instance of siliceous aggregation. Can one doubt that the great vein of ochre in the same locality has a similar origin? Similar veins of quartz, and at short distances of iron ore, are to be found traversing the Devonian fossil-beds of Bedruthan in St. Eval, in which many of the organic remains of their casts seem to have been preserved mainly by their attraction for iron. Dufrénoy describes the conical hill of quartz called St. Priest, in the coal-basin of St. Etienne. Its summit is pure quartz, bearing impressions of calamite stalks and of leaves analagous to those in the coal-measures. —The veins of auriferous quartz in Silurian rocks in Australia, so ably described by Brough Smith, may be referred to similar causes. M. Laur published in 1863, in the Annales des Mines, his observations on the warm springs of California. He considers the elevation of the Sierra Nevada as posterior to the most recent tertiary, but anterior to the eruptive basalts and trachytes. Lecoq concludes that the greater produce of gold in the upper part of the quartz-veins, as in the Ural Mountains, was owing to the condensation of the vapour as it reached the colder rock. M. Laur believes that the appearance of gold in California is comparatively recent, and in some places contemporary, as in the Steam Boat Valley at the foot of the eastern slope of the Sierra Nevada, about eight hundred fathoms above the level of the sea. In winter, the hot water boils up for seven or eight feet from many straight parallel fissures, in summer its ebullition may be heard at a small depth; carbonates and sulphates of soda are their principal solid contents; they also deposit silex and oxydes of iron in other fissures a mile distant which give out vapour. Silex is found for thirty or forty yards on either side, both as a compact rock and in blocks of great bulk. This rock contains oxyde of iron, manganese, and sulphides of iron and copper, and gold in flakes. M. Laur assigns to a similar origin the deposits of auriferous ochre in the "placers," in some of which a piece of quartz is rarely seen. That the deposit of metals in different combinations and in different parts of fissures, in some in preference to others, must, one conceives, as Robert Fox maintains, be due to electro-magnetic currents, whether the minerals may have been segregated from adjacent rocks, aided by water from above, or, as

I have no question was mainly the case, brought up from great depths.

If fishermen had lived on the forest-marble of Wiltshire, still shewing rippled marks, broken shells, and fragments of drift-wood, their nets, as in the present day, might have been torn by a crab recently found there, which, Woodward says, closely resembles the spider-crab of our shores. He also described a new genus of cirripedes, from Dudley, which carries this group down to the Upper Silurian. But if the spider-crab of the oolite be still rife amongst us, happily a reptile lately discovered by William Fox, in the Wealden, near Brook, in the Isle of Wight, has departed time out of mind. The specimen belongs to the Dinosaurian family; the head and neck are wanting. The body was six feet in length, with a massive tail as long: on its back was a great bony shield; the remainder of its body was covered with long armour-plates of bone half-an-inch to four inches in diameter and half-an-inch thick. Professor Owen has given it the name of *Polacanthus*, on account of the remarkable osseous-like processes extending along the body and tail: some of them are fifteen inches long and weigh seven pounds. His examination of a young specimen has discovered its greater affiinity to the mammalia than is found in existing reptiles, since it was evident that like the mammalia it increased the number of its molar teeth according to age, whilst in crocodiles, &c., the number of teeth and sockets has no reference to age.

M. Sanna Solaro made an interesting discovery of a pelvis of a Dinotherium, six feet across, in soft marly sand (in Haute Garonne); there was the head of a small bone situated at the side of the cotyloid cavity which he suspected to be a marsupial bone: he found, also, fragments of a flat angular bone belonging to this head. Hitherto, only small fossil marsupials, or living ones, such as the opossum, have been found out of Australia, whereas this species must have exceeded in size the Diprotodon of Wellington valley and the largest Indian elephant. Well for the geologist that he fell in with this monster dead rather than living, for thus, instead of placing its bones in a museum, he might himself have been deposited in the pouch of the marsupial to have been examined at leisure in

his cave. Owen describes the kangaroo and Dinotherium as presenting the same type of molar tooth, the fangs in both are impressed by a longitudinal groove.

The fossil-remains of Attica, so carefully investigated by Albert Gaudry, convince him that many of them are characteristic of the middle tertiary epoch, and approach very near to those of Africa and India, while they are entirely distinct from all the genera, living or extinct, of America. A. Gaudry concludes that at or about this epoch, that continent was separated from the old world. Amongst the quadrupeds are several new species of Pachydermata, including a new Mastodon, two new Palæotheria, two giraffes, some quadrumana, and birds. It probably would never have occurred to that great philosophical naturalist Aristotle, if he had disinterred those apes in his native region, to "unsphere the spirit of Plato to unfold" to him which amongst them was the direct ancestor of his Great Master.

The committee appointed to examine the undisturbed parts of Kent's Hole, near Torquay, have presented to the British Association a detailed report of their successful and accurately-made researches, which confirm previous statements as to the works of human hands being found in the red loam below the stalagmitic crust, mixed with the bones of extinct animals, such as the lion, hyena, rhinoceros tichorhinus, and mammoth, the specimens of the latter being probably young ones; some of the bones were gnawed and some rolled. The members of the committee have not the smallest doubt that those who charred the wood or brought the implements into the cave were contemporary with the extinct animals. Some may ask, as does Professor Phillips, "Did men and these extinct quadrupeds live in the same day, or do we see the relics of different periods gathered into one locality by natural processes of a later date or confused by the operations of man?" To this, Professor Phillips hopes that further researches in Kent's Hole and in the Gibraltar fissures may aid in giving an answer. Can it be deemed improbable that man existed before the latter generations of the now extinct pachydermata and carnivora had gradually died out, either from change of climate or deficiency of food, as in the case of the

Dinornis in New Zealand, and of the Dodo in an island about four miles square near the Mauritius. These quadrupeds, doubtlessly, existed in England before the German Ocean extended so far south. Vambery speaks of some of his fellow-travellers having been alarmed one evening near the Caspian, and in the latitude of Cadiz, by the sight of two Bengal tigers. Professor Jamieson's observations in his highly interesting paper on the last changes in Scotland, on the evidences of subsidence, and of the rising of the coast-line, of which your own journal record several local instances, should stimulate us to continual observation of similar facts, at the same time carefully sifting them; as for instance, the name of the original owner of the human skull found in tho Carnon stream-work, as mentioned by Sir C. Lyell, might I believe, still be found in the parish register. Professor Jamieson has examined many of the shell-mounds left by man near the mouth of the Ythan, in Aberdeenshire; with them are pieces of burnt twigs and stones that have been in the fire, with teeth and split bones; pieces of artificially chipped flint are found on the surface of some of these mounds, and are abundant in the immediate neighbourhood; they must have been later than the raised beaches, as they are not more than four feet above high-water mark. Dr. Bryce, from his recent inquiries in Ayrshire, places the remains of the mammoth and reindeer found there below the boulder clay, as they have often been found in England. How wide the interval between these shell-mounds and the post-glacial raising up of Moel Tryfaen 1,370 feet near the Menai Straits, having in the drift on its top fifty-four species of shells still living in British or more northern seas! When I was in Parma last autumn, Professor Strobel gave me his report on the traces of the very numerous lacustrine dwellings in the Emilia, with drawings of the stone and metallic tools, pottery, &c., found on their sites. Professor Gastaldi, of Turin, has since published a work on those found in Lombardy, of which C. Chambers, M.P., has just given us an able translation, with faithful plates of the objects found.

Can any one taking a part in associations to promote social advances, not pause from time to time to consider how such or such

associations have accomplished the object in view, and what is of deeper import—are they worthy of pursuit?

It will be seen that you have not worked in vain, whether we recur either to the collection in your museum, now, I am glad to say, placed under the care of Dr. Le Néve Foster, a practical geologist as well as metallurgist (who has kindly consented to be your curator), or, to your published or unpublished Transactions, including William J. Henwood's encyclopædic volume of his researches amid the rocks and metalliferous veins, cross-courses, and elvans of this region, the more valuable because, from the suspension of many of the mines thus explored, memory, instead of accurate records, must have been appealed to for information.

I need not now speak of the many honoured names of those removed from us, who, when geology was in its infancy, explored their native region with a genuine insight, and pointed out those facts which formed, as it were, the ground-plan for further researches. A few fossil traces, the fragment of a shell, or the eye of a trilobite, as it were, in a small "primer" of fossil-remains at Gorran, led on Charles Peach to study the whole language of geology, first here, and then in the ampler pages of Scotland. Some of us who are growing rather fossilised ourselves, must invoke the aid of younger men, carefully to re-examine every part of the county, not forgetting the vast facilities afforded by our quarries, mines, and extensive coast-line, by which they might greatly promote the object of this society, and school themselves for other regions. The temperature and analysis of our thermal springs, as all those in the deepest mines may be called, ask for renewed investigation.

The commercial benefits of geology are so patent as to be almost universally admitted. It is no light matter that to succeed or be useful in it, men must learn themselves to observe accurately, and so to correlate facts as to bring order out of seeming disorder. I said men, but ladies also, some of whom, your own contributors, have shown their ability in the pursuit of this science, which cannot be distasteful to the most refined woman, whilst it brings before her eyes the flora and fauna of polar and tropical regions, beings of

primeval times, or their living analogues, whilst the most delicate may be strengthened by the unwearying pursuit in the fresh air of ever-new objects of interest. Professor Hunt has preserved for us a very curious history of the legends of Cornwall: I am glad that he has lived to see the myth of the fairy with her pick in the lode, and of the fairy prince and princess dining at St. Just, more than realized, when the royal pair descended to geologise far down under the Atlantic, but did not leave their tools on a cliff of the rock as the fairies were said to have done. The Prince's gracious answer to your Address will be read by the secretary.

The sciences are mutually so dependent or illustrative, that from all geology derives assistance: spectral analysis not only discovers new elements in our earth, but also those of our sister globes. Foucault, in a room not larger than this, measured the velocity of light, and thus corrected the estimated diameters of the planetary bodies, and indirectly their assumed density also. I suggested, in 1863, that the difference in the colour of binary stars was perhaps owing to their respective phostopheres being in different allotropic states, because sulphur and nitrogen assume different colours, according to the degree of ignition. Professors Huggins and Miller have announced that the nebulæ are masses of luminous gas—hydrogen, nitrogen, and an unknown substance. How marvellous, that these gases, everywhere in and under the surface of our globe, should be also discovered at an immeasurable distance from it!

If we have recently accomplished but little towards those advances in geological science to which I have been referring, we may say, in the words of Professor Phillips,—"Whatever be our own success in the rich fields which lie before us,—however little we may now know, we will endeavour to prove that in this our day we know, at least, the value of knowledge, and join hearts and hands in the endeavour to promote it."

THE FIFTY-SECOND ANNUAL REPORT OF THE COUNCIL.

SINCE the appointment of the present Council their attention has necessarily been more engaged in considering and carrying out the minor detals of the arrangements of the building of the new museum, and the business connected therewith, than the more scientific part of their duties.

It will not be necessary here to recapitulate all the various matters that have been brought under their notice, but simply to give a statement of what has been determined on and agreed to by the various committees.

In February a communication was received by your secretary from the directors of the Penzance Public Buildings Company, to the effect that they intended making an alteration in their Building by extending it northward. A meeting of this Council was immediately convened, the matter being of such importance to the building interest of this society, and after duly considering the draft of the deed of conveyance, the following resolution was passed:—

"That the architect be instructed to prepare a plan for a museum, and other rooms in connection with it, on the piece of ground not now being built on, and on to the full extent of the society's building right." On this receiving the approval of the parties interested it was further resolved, "that a clause be inserted in the conveyance-deed that this society shall not be bound to build in exact accordance with such plans, but that it binds itself to build in conformity with the elevation."

On the 28th of April another communication was received from the directors of the Penzance Building Company:—

"That an application be made by this society to the Geological Society for leave to open windows in the western wall, as shown in the plan now produced by the architect, and of which a copy shall accompany this application, and which windows shall remain open only during the pleasure of the Geological Society, and be closed by the Penzance Public Buildings Company within one month after receiving notice in writing to do so."

The Council met on the 15th of June to consider this application, and after carefully considering the plans, resolved, that permission be granted on the terms named, on payment of 1*s*. per year, from the 1st July, 1865, and that there be a clause inserted in the Deed to this effect.

At this meeting the resolution of the 1st of March was confirmed, and the president empowered to sign the plans and elevations. Resolutions were also passed recommending the trustees to sign the Deeds of conveyance on the assertion of the clauses referred to, and others of mere detail which had received our attention.

It affords us no little satisfaction to inform you that these various alterations have been formally approved of by the several parties interested.

We had hoped to have the pleasures of laying the Deeds before you at this meeting, as they are now complete, but the unfortunate illness of our solicitor, Thomas Cornish, Esq., which we trust is but of short duration, has prevented this desirable arrangement from being carried out.

We deem it right here to record a resolution passed by the joint building committee on the 19th of May. In order to save the expense of separate sets of plans for each Deed, "that a complete set of plans shall be prepared and deposited between all parties in the town-safe, and that the same shall be incorporated in each Deed by reference." The building progresses favourably.

It is with pleasure we have to inform you that Dr. Le Néve Foster, of the Miners' Association, has kindly undertaken the office of curator.

As the time of our remaining in these rooms is now so short, we recommend that the collections of minerals and fossils in this museum be re-arranged and classified, and that as each series is made more complete, it be packed away in boxes ready for removal.

The suggestion of your last Council respecting a new code of rules has not been lost sight of, or the valued remarks of Professor Hunt on the desirability of circulating a series of questions on mineral deposits, veins, and other mining phenomena, among the mine agents and others interested in mining—for their replies and remarks; but we are not at present prepared to make a report on them, but venture to suggest that you empower your Council for the ensuing year, to nominate from amongst themselves sub-committees to take these matters into consideration.

Since the last annual meeting, this neighbourhood has been honoured with a visit from His Royal Highness the Duke of Cornwall, the vice-patron of this society, and Her Royal Highness the Duchess of Cornwall.

We have to note the occurrence of two rare minerals in this locality—"atacamite," for the first time found in this neighbourhood, if not in Cornwall, in Huel Cock Mine, St. Just; and a curious formation of carbonate of iron, found in Botallack.

The "Eighth Volume of Transactions"—having been nearly seven years in progress—has reached its 402nd page; and the Council confidently expect it will be completed within eighteen months from this date.

The 48th, 49th, and 50th annual reports are now ready for circulation.

The Council have the melancholy duty of recording the deaths of three amongst the oldest members of the society—Edwin Ley, Esq., Richard Millett, Esq., and E. J. Griffith Cole, Esq.,—each of whom took a lively interest in your proceedings, and had each, on more than one occasion, filled the office of vice-president and member of the Council.

We beg to call attention to the treasurer's report, and venture to repeat the remarks of the last Council:—That being £500

deficient on the Building-fund, strenuous efforts should be made by the friends of the society to collect funds sufficient to enable the society to enter the new museum without a debt.

In concluding their report, your Council consider that the time has now arrived to extend the benefits of this institution, and recommend that steps be taken by the next Council to organize a course of Lectures on geology, &c., to be delivered in this museum during the coming winter months, and also to carry out the original intentions of the founders by holding quarterly meetings.

By order,

SAMUEL HIGGS, JUN.,

Secretary.

October 24th, 1865.

DONATIONS TO THE MUSEUM.

1. Specimens of Silver and Copper from Lake Superior. By Mr. Nicholas Berryman, of Zennor.
2. Atacamite, from Wheal Cock; and Carbonate of Iron, from Botallack. By Samuel Higgs, Jun., F.G.S., F.S.A., Secretary of the Society.

DONATIONS &c. TO THE LIBRARY.

1. Mining and Smelting Magazine. By the Editor, H. C. Salmon, Esq., F.G.S.
2. Quarterly Journal of the Geological Society. By the Society.
3. Philosophical Magazine.
4. Annual Report of the Trustees of the Museum of Comparative Anatomy.
5. Proceedings of the Royal Society. By the Society.
6. Proceedings of the Royal Society of Edinburgh. By the Society.
7. Memoirs of the Geological Survey of India. By Thomas Oldham, Esq., LL.D., F.R.S.
8. Boston Journal of Natural History, with the Laws of the Society. By the Society.
9. Smithsonian Contributions to Knowledge, with results of meteorological observations. From the Society at Washington.
10. Quarterly Journal of Science.
11. Report of the British Association, 1833. By the Association.
12. United States Court Survey. By the Government of the United States.
13. Vols. 16 & 17 of the Palæontographical Society.
14. Proceedings of the Literary and Philosophical Society of Liverpool. By the Society.

TREASURERS' ACCOUNT.

INCOME.	£	s.	d.
Balance Petty Cash	4	7	1
Subscriptions from His Royal Highness the Prince of Wales	20	0	0
Subscriptions from ordinary members and arrears	87	8	0
Rent of Gentlemen's News Room	7	7	0
Balance due to Treasurer	9	17	5
	£128	19	6

EXPENDITURE.	£	s.	d.
Balance from 1864	16	0	8
Rent, Rates, and Taxes	45	15	8
Housekeeper, &c.	6	4	9
Repairs, Coals, &c.	5	3	6
Insurance	2	17	6
Expenses per Secretary and Treasurer	5	7	8
Printing, Stationery, Advertising, &c.	40	12	9
Subscription to Palæontographical Society	1	1	0
Expenses connected with the ceremony of Laying Foundation-stone	5	3	5
Balance Petty Cash in hand		12	7
	£128	19	6

ROYAL

Geological Society of Cornwall.

FIFTY-THIRD

ANNUAL REPORT

OF THE COUNCIL,

WITH

THE PRESIDENT'S ADDRESS,

THE CURATOR'S REPORT,

AND

PAPERS AND NOTICES

READ TO THE SOCIETY.

PENZANCE:

PRINTED BY W. CORNISH BOOKSELLER AND STATIONER.

—

1866.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness.

Her Most Gracious Majesty the QUEEN.

Vice-Patron.

His Royal Highness the Prince of Wales, K.G.

OFFICERS AND COUNCIL FOR THE YEAR 1865/6

President.

Charles Fox, Esq.

Vice-Presidents.

Thomas S. Bolitho, Esq.
Richd. Davey, Esq., M.P., F.G.S.
John St. Aubyn, Esq., M.P.
Sir William Williams, Bart.

Treasurer.

William Bolitho, Jun., Esq.

Secretary.

S. Higgs, Jun., Esq., F.G.S., F.S.A.

Librarian.

Edward Hearle Rodd, Esq.

Curator.

Clement Le Neve Foster, Esq., B.A., D.Sc., F.G.S.

Council.

Edward Bolitho, Esq.
William Bolitho, Esq.
Richard F. Bolitho, Esq.
Samuel Borlase, Esq.
Walter Borlase, Esq.
Rev. John Carne, M.A.
John S. Enys, Esq., F.G.S.
Robert Were Fox, Esq., F.R.S.
D. P. Le Grice, Esq., M.A.
Samuel Higgs, Esq.
W. D. Mathews, Esq.
Rev. M. N. Peters, M.A.
John Jope Rogers, Esq.
Robert Tweedy, Esq.

PRESIDENT'S ADDRESS.

The Report of your Secretary will give you full information on the progress of the Building, and on other portions of the business of the Society.

Whilst we think with a lawful pleasure on the persistence of this Society during more than fifty years, there are from year to year, associated with it great regrets at the removal by death of some of our ealier members. Amongst them, we have now to lament the loss of the venerable Colonel Scobell, who became a member of the society at an early period; he has since filled the office of vice-president, and was always ready personally to aid its operations.—The late John Rule was necessarily absent from this country during several years whilst acting as manager of large silver mines in Mexico; but, whether at home or abroad, his observing eye and collected intellect were directed to the collating geological and minerological phenomena.—As an analytical mineralogist, Percival Johnson of Hatton Garden was well known throughout the kingdom, and seemed to take especial interest in the varied metalliferous products of this county.

Now, one naturally turns to the youngest men amongst us and to the happy increase of our members, and calls on them to aid this society in every way. Facilities for travel bring new regions within their reach, whence they may bring much fresh matter to communicate in your Transactions, and geological specimens of every kind to enrich your museum. Let us not be content with the prestige of the past, nor allow the society to be looked on as a vacant cranium, entombed indeed in a splendid mausoleum, but with no traces of its early and vigorous life.

At our last meeting I alluded to a burial-place of great antiquity —the Laurentian Gneiss,—since which the existence of the *Eozoa* in it has been doubted by Professors King and Rowney. Dr. Carpenter, who has a most intimate acquaintance with the *Foraminifera*, has been confirmed in the opposite conclusion by a further examination of specimens sent to him by Sir W. Logan: he finds that the proper wall of the chambers exhibits the finely-tubular structure of the nummuline *Foraminifera*; the acicular fibres he deems to be internal casts of the tubuli once occupied by the minute filaments of the animal. A recent siliceous cast of a *Foraminifer*, dredged near Australia by J. B. Jukes, has also the asbestiform layer. Dr. Carpenter confidently asserts that no parallel can be shown in any mineral product to the nummuline structure of the chamber-walls. The strong-smell of some of the Laurentian marbles, as observed by Sir W. Logan, seems to indicate their organic origin. Dr. Carpenter's views are strengthened by the discovery by Dr. Gümbell of Munich of *Eozoa* in stratified calcareous serpentine of the Hercynian gneiss, also of a second species *(Bavaricum)*, similar to that of Connemara, in a granular aggregation of serpentine hornblende and calcite in a clay-slate, supposed Cambrian or Huronian, as well as by specimens from Cestra-Lipa in Bohemia and others from fundamental gneiss near Mauldau. Dr. Dawson has found the *Eozoa* simply preserved in carbonate of lime.

If the Connemara serpentine be Lower Silurian, as Sir R. Murchison supposes, and the "*Eozoic*" ophite occurs in the Devonian system of Syracuse (New York), and that of the Isle of Skye be Liassic, these simple organisms must have existed through a vast period of time, confirming the opinion that the more rudimentary forms are the more persistent. Possibly they might also be detected in the serpentine of St. Veep (if it be not there an eruptive rock), having fossiliferous slates in its western side (or wall). In connexion with gneiss should be mentioned the organic impressions observed by Professor Sismonda in a boulder of that rock in the diluvium overlying the lias in the Brianza; the neighbouring Valtellina mountains are of the same form of gneissic rock:—Brognairt thinks that it may have been the cast of an *Equisetum*. The Professor

supposes it to be a metamorphic rock of the carboniferous age.

As we have access in this county to specimens of granite two hundred to three hundred fathoms in depth, it might be well to examine some of its crystals containing fluid, and to ascertain at what temperature it would fill the cavity, as illustrated by the miroscopic experiments of Sorby and Bryson; the latter found in numerous specimens that the air-bubble disappeared at a temperature of 94° and re-appeared with a singular ebullition at a temperature of 84°. Would there be a difference in crystals from a depth at which a higher temperature at the present time than 94° might be expected? Don C. De Prado writing on the granite and other rocks of Madrid confirms Le Coq's view, that to mineral springs are due the large irregular masses of silex existing there, which the Tertiary limestones also contain to the extent of from twenty to forty per cent. There are islets of granite in the gneiss which he believes to be metamorphic, having inorganic calcareous bands interstratified. Rocks between the Silurian and cretacous rocks are wanting; these, like other cretacous rocks in the South of Europe, are deficient in *Ammonites*. A fossil *Melanopsis* has been found in Spain, the only country in Europe having a living species of this shell, which I have often seen in Syria. Mr. Bone has found in Turkey metalliferous porphyries, diorites, and serpentine piercing the Eocene beds.

You possess in your Library valuable communications on the Geology of Norway; that of the north-west coast, with its far-penetrating fiords and glaciers reaching the sea, offers a wide and but little explored field to our English yachtmen and fishermen. Nearly forty years ago they filled me with admiration and conjectures, when the glacier theory and that of subœvial erosion were yet in their infancy, and Siluria had not seen the light. In the Geology of South Norway, Kierulf's illustrated work and the Transactions of the Christiana Society fill up some important gaps. Kierulf is fully convinced (as Sir R. Murchison suggested in 1844) that the Silurian rocks, as well as the deeper Cambrian, and the Devonian above, lie in contorted waves from the Dovrefeld by the Miösen See to Christiania Fiord. He thinks that the various

eruptions of granite and trap took place at different periods. The Silurian rocks seem pressed together on every side by the granite, syenite, and porphyry:—the latter and earlier fossils are so intermixed by these folds that very erroneous conclusions might be drawn as to the relative ages of the strata.

J. B. Jukes's survey of the Devonian rocks and Old Red Sandstone of South Ireland has led him to suggest a correction in Professor Sedgwick's succession of rocks dipping one under the other from Linton to South Molton. He would separate the Old Red from the grey slates containing marine fossils, supposing the slates in one district to be a repetition of the other. He points out a great fault, like that of Slievenmuck (4,000 feet), in Ireland, where the Lower Silurian slates are in direct apposition with the coal measures. He asks, do the Devonian beds belong to the carboniferous limestone or to the Old Red? and if Silurian fossils on the one hand, or Liassic on the other, had been found in these Devonian beds, would they not have classed with one or the other?

The Devonian rocks are said to include a few Silurian fossils not known in carboniferous limestone, as they undoubtedly contain nearly one hundred species found also in the latter. J. B. Jukes demurs to the presumption that these Devonian beds were contemporaneous with the Old Red, and maintains "that the orological relations of fossils and the necessary laws which regulate their appearance in time, have yet to be treated of independently; we must not forget that the chronological significence of organic remains is a secondary and derivative one only, depending alone, either directly or indirectly, on the stratigraphic succession of the bed." He allows no definite value in themselves to the Devonian species and genera of fossils as fixing their exact place in the series of rocks. He concludes, that the true Old Red containing no marine fossils (the few plants and *Anodonta* being apparently fresh-water) is the conformable base of the great carboniferous formation, in North Devon as in Ireland, and that the Devon beds proper lie side by side with the carboniferous lime.

J. B. Jukes refers the difference in fossils to space rather than to time, instancing that between the Bohemian and Scandinavian

trilobites. He quotes R. Etheridge's recent Catalogue of the 405 Devonian fossils, of which only one (a *Serpula*) has been found in the Old Red; only thirteen of these (chiefly coral) are said to occur in any Silurian rock, whilst ninety-two or nearly one-quarter, are found in other undoubted carboniferous rocks of the British Isles; these, he thinks, will be found most diffused and most abundant in both formations.

Professor Gümbell states that the Silurian, Devon, and carboniferous rocks are wanting in Franconia, where the conglomerates of the Dyas forming the basis of the Trias rest on the crystalline primitive rock; the fossil *Lophiodon* of that region is classed by Dr. G. A. Maack in the great family of omniverous *Pachydermata*, but divided from *Tapirs* and *Palæotheria*, although its teeth have strong points of resemblance. Professor Owen would probably not agree with him that there were grounds for separating the latter two families from the *Lophiodons*, which he supposes to be the most ancient of the *Pachyderms*.

One would wish to remember Professor Owen's generalisation, that the number of true molar teeth is constant in the diversified form of the existing *Ungulata* (not proboscidean), and that the inferior complexity of the pre-molar to that of the deciduous teeth which they replace, has prevailed from the time of the earliest hoofed *Herbivora*.

The formation of our valleys may claim the attention of our pedestrian geologists; we may not be able to find the great lines of faults to which many valleys in sedimentary strata are mainly due, and we must partly adopt Sir R. Murchison's opinion, "that the wear and tear due to atmosphere or subaerial erosive agency, would not in countless ages have originated or even deepened any of the valleys or gorges in countries as flat (for instance) as the tract around Birmingham, or that the action of deep seas remote from coasts can adequately explain the denudation of the old surface." But if we fill up many valleys in this county we shall probably find that their depth and extent generally bear some proportion to the elevation of the ground whence they start, and to the number of tributary valleys. From the nature of our rocks there is a great

difficulty in ascertaining whether elevation and tilting of the strata is due to erosion by ice or rivers, or the action of the sea; but in killas, when the strike of the bed happens to be across the valley, the amount of erosion thus occasioned may be visible. At the eastern end of Dolcoath mine the granite, at nearly seven hundred feet deep, forms a great trough on which lies a conformable bed of killas, altered at the junction, forming a valley in which a stream flows; in the neighbouring mine of East Pool, there is not only a valley in the granite below the killas, but also a hill-top of the same rock, not attaining the surface by more than a thousand feet. The metalliferous, or quartzose, veins which cross some valleys might be examined for indications as to their priority in time to the formation of the valleys themselves. Rocks of quartz lower down a gorge would lead to the conclusion, that if a bed or vein of it crossed the valley, the latter was one of erosion. Then, as to metalliferous veins; although certain changes might take place in the minerals of their upper portions after the air or salt or fresh water had had access to them in valleys cutting through them, there are some minerals, such as the tin ores, fluor spar, and the relative positions of copper and iron pyrites would be little affected by such agencies, and if they rose with the hill (unless the rock was changed in nature or hardness), one might presume that the veins were filled since much of the valley had been formed.

Geike's very able work on the effects of rivers in cutting their way across the ridges of Silurian and other rocks should make us cautious in limiting the erosive powers of water. Jules Marcom has observed how much it has accomplished at Niagara since 1850, where the table rock has almost disappeared at a rate which he thinks will carry the Canadian fall in eight hundred or a thousand years up to the Three Sisters Islands, and the American fall will not be whipped but washed out of creation. That we cannot weigh the various causes that have disturbed the earth's crust, we may learn from the great basin in the Atlantic from twenty to thirty thousand feet deep.

J. Crill's calculation on the change in the centre of gravity of the Earth north and south during the existence of ice at the

respective poles alternately, and the consequent submergence of part of the corresponding hemisphere under the sea, may be substituted for subsidence of the land. Professor Thompson gives a simple formula for calculating this rise, from which it would result that, taking the area of the land to be half of that of the sea, and the thickness of the cap of ice to be six thousand feet, thinning out gradually to latitude 55°; and taking one-sixth and one-fifth and a half as the densities of ice and water respectively, the rise of sea at one pole and depression at the other would amount to three hundred and eighty feet. The assumed thickness of the ice is probably much below what occurred in great glacial periods, as well as its limits in the northern hemisphere to the latitude of Moscow, Lake Winnepec, &c. The vast amount of water from the melting of the ice, its forward movement, and the action of the sea, both in its gradual rise and fall and altered tidal action, must have greatly changed the contour of the land. In the African equatorial region lately disclosed to us by Capt. Speke and Sir S. Baker, we have yet to learn the relative period of the elevation of the granite mountains, which determine the water-shed towards the north, and what part the sea may have had in the structure or denudation of the surface when it also covered the now high table-land of the vast Sahara.

The present investigation as to the extent of our coal-fields in which Robert Hunt one of our members is engaged is of geological and national interest. Sir R. Murchison would moderate the sanguine expectations of those who, as another of our members H. Vivian, argue that coal may be found in the south-eastern part of England because it exists at Valenciennes under the chalk, and towards Calais under cretaceous deposits. But Sir R. Murchison thinks that no productive coal-measures can be looked for in the south-eastern counties, nor where rocks older than the carboniferous rise to the surface, as in Herefordshire and a great part of Wales. Although the coal-measures dip at Valenciennes in the north at a high angle, and extend westward beyond Bethune, the coal seems to be completely cut out by the Devonian limestone and grits near Boulogne. He deems it possible that the portion of the oolite

series north of Boulogne may be continued under the cretaceous and Wealden rocks of Sussex and Kent; below this, Devonian only. On the west is found the carboniferous limestone underlying the coal-bearing strata in the south of England and Wales. Then can we hope to find coal east of the forest of Dean amidst Old Red sandstone and Silurian rocks, under the Cotteswold hills, or in the vale of the Severn, and where the New Red lies upon the crystalline and other rocks of the Malvern hills? He believes that any extension south of the Stafford and Leicester fields will be at too great a depth. But Sir R. Murchison is confident that there are vast supplies of coal beneath the Permian and New Red in the midland counties which his geological experience led him to anticipate thirty years ago. He thinks that the recent well-sinkings at Harwich through a depth of 1,025 feet of cretaceous rock, where a hard slaty and the lower carboniferous rocks were met with, would forbid sinking for coal to the east or south-east of the Cambrian or Lower Silurian rocks of Charnwood forest. Bradley of Richmond, the author of an admirable book on the Lead Mines of Swale Dale is boring experimentally between the Tees and North Allerton through the New Red sandstone and magnesian limestone, hoping that good coal may be found beneath these strata, as the carboniferous limestone east of Middleton Tyas dips rapidly.

Looking south, along the magnesian limestone, Sir. R. Murchison remarks on the most satisfactory and progressive thickening of the coal beneath, whilst between Mansfield and Nottingham it becomes thicker and richer beneath this rock, in a region where a few years since only geologists hoped for it. About twenty years ago a very experienced viewer held up to me this magnesian limestone as conclusive against any hope that a large colliery with which I was connected would not be cut off by that rock. Sir R. Murchison estimates the existing and possible coal-field of England and Wales at about six thousand square miles. We all know the differences of opinion there are as to the depth at which the lower seams can be worked; by some the progressive increase of temperature has been deemed of no consequence. But it would certainly be unsafe to depend on the possibility of reducing the temperature of the

rock at a great depth; this may vary partly according to the conductivity of the particular strata, but still more according to the facilities for the ascent of hot water or vapour from greater depths. No practicable ventilation will enable men to work at a depth of two thousand yards. If we take the temperature at 76° in the Dukinfield colliery at the depth of about two thousand one hundred and fifty feet, and add an increase of 1° for every sixty-five feet (the mean between that colliery and the Salt-works at Rehne) we reach a temperature of more than 135°.

Does not Grove speculate too much on the progress of science to hope that man will be able to utilize and concentrate a portion of the sun's heat, when we have consumed our coal in which it has been stored?

As we should in vain seek for vital force in alcohol in lieu of its developement from the conversion of organized Pabulum into blood,—how, without fuel, should we prepare or separate those metals or other substances which give intense heat in combustion?

Sir Charles Lyell has ably maintained the view that causes still in operation were sufficient to have produced the great changes in the original surface of the earth; but many of us will agree with Sir R. Murchison that some of these great physical changes were due to the crust of the earth having been affected from time to time by an agency much more powerful than any thing that has been experienced in the historic era. Can we, from any known phenomena of solar heat, or of changes in the position of the earth's axis relative to the sun, or from the eccentricity of her orbit (unless she at any time drew more than her share of what Sir John Herschell calls the planets' common fund of eccentricity), account for the existence of the Lower Miocene flora in the North of Greenland (unless, as J. Croll calculated, the temperature might thus vary in the proportion of 19 to 26°)? Professor Heer has distinguished sixty-six species (of which eighteen are found on the Miocene of central Europe). We know of no existing analogues of one or two of the genera; but Professor Heer asserts that the temperature must have been 29° higher than at present. He believes that the firs and poplars found near Disco and Spitzbergen must have reached even

to the Pole itself, and that no insular condition could have modified the climate to such an extent. R. Etheridge wants to have this conclusion confirmed by fossil mollusca. Professor Ramsay cannot understand how those plants, some of them evergreens, could have had sufficient light during half the year at the North Pole. There are great breaks in the supposed regular, continuous action of Sir Charles Lyell as affecting the unorganized surface of the globe. Is not W. R. Grove's doctrine of continuity in organic existence open to much greater objections? Selection and continuity are feeble substitutes for the designs of Creative power; nor will the difficulty be removed by the theory that out of a few simple forms (one perhaps the Eozoon of the Laurentian gneiss) were in the beginning designed to be evolved those of the beautiful flora or fauna, extinct or recent, which people this fair earth. It is a favorite illustration that to design a reproductive watch would require more skill than to form one, only, or even a chronometer like that of the *Great Eastern*, which lost only one twenty-fifth of a second in the Atlantic. We are asked to believe that vital forces once set in action give rise to innumerable modifications of those forces, both in degree and in kind, as represented in the perfect and harmonious whole of every organism; as if a watch were not only to produce a watch, but, in successive generations, every other mechanical contrivance adapted to surrounding conditions.

The accomplished naturalist Charles Darwin seems to have contemplated organic life as a great game carried on through countless ages, of which the cards were so skilfully dealt at first, that every Being came out of it a winner, through all the inevitable turmoils of time and place. He seems to have used the power of his genius to persuade us that the Omnipresent Master's hand did not regulate the notes of the choral song of the Creation, which he has failed to observe in its divine harmony, lost though its sound may have been at times in the roar of a chaotic sea; or to have heard the "lofty diapason ending full in man," whom a great thinker has poetically called "Nature's first dialogue with God."

A Geological Meeting is not the place to vindicate the ways of God to man, but the subject may fairly bespeak our attention;

because it bears on the former relations of land and sea, on climate, and on the chronology of extinct forms,—as from the scattered statues, the dissevered frieze, and the still standing columns of the Parthenon—we can yet discover the plan of this masterpiece of its skilful architect.

As all the animals yet discovered in the vast deposits up to the Higher Silurian inhabited the water, we may ask, how did the land animals originate from those? No vertebrate has been found earlier than the fishes of that bed.—Where do the four-plate corals of the limestone change into those above the Permian with six plates?—Yet one species of each seems to have changed places in the Silurian and cretaceous rocks. Had not the fishes of the Old Red sandstone as high an organization as any of the present day? The fossil Zenglodon whale is ranked by Professor Owen as the earliest and yet the most developed of the carnivorous cetaceans. Professor Huxley admits that among numerous cases of variation he found none of progression: he has described five new genera of reptiles from the Kilkenny coal with ossified vertebræ, but not as in *Archegosalurus*, with persistent branchial arches. Remarking on them, Professer Hamilton says,—"We find in the carboniferous deposits the very conditions of life most suitable for reptilian existence, not in one or two vague forms developed out of previously existing ones, but in a great variety of new ones, all reptilian, varying on different hemispheres." W. F. Grove says, if an elephant were created without progenitors, the first elephant must some way or other have arrived physically on this earth, and did he fall from the sky?—did he appear out of the cleft of a tree? One might ask the learned president to put his finger on the forms on the lower rocks that were converted into reptiles, especially air-breathing ones. He admits that the non-observation of sudden enactions viewed with reference to the immensity of time cannot be regarded as disproofs of their reptile occurrence. The metamorphoses of crustaceans from the time of Barrande's primordial zone to the present day—as well as those of insects of the coal age—would have seemed to afford the fitting moment in their plastic state for alteration of structure, but have any but accidental monstrosities been observed?

Any one who is familiar with the observations of such a comprehensive and experienced botanist as Dr. Hooker will be disposed fully to admit that there are great variations in species, both of plants and animals: he would reduce the estimate of flowering plants to one-third of the number given by some botanists; for, he finds that varieties retain their characteristics over great areas, and lose them in others. In Nebrasca, the genera of cretaceous plants recur there in living forms. Dr. Hooker suggests that certain forms, by which genera and orders were originally connected, are extinct; but he has then to face the admitted fact that there are bounds to these variations, both as to degree and kind;—that, as a rule, hybrids are sterile, and that species are real, and not imaginary, whether for a time only, or not; and then refers the question to Darwin's arbitrament of the sword, to the struggle for existence.

Dr. Hooker thinks that there are natural groups of stable and of unstable forms of plants—the unstable prevailing in those of the least complex structure, and much more numerous than the former, such as the easily characterized Orchids and grasses,—the latter happily still existing as the main sustenance of man and beast.

How did the contrast between endogenous and exogenous plants arise? In animals, the diversity in parts of the structure of members of the same order, as resemblance in the modifications of structure in those of very aberrant orders, strongly indicate design. How has the warm-blooded mammalian whale acquired vitality to prolong his individual life, from the time of the Norman Conquest to the present day?—having the fringed laminæ of his palate (where the waves leave their spoil as in a sieve) so entirely different from the teeth of his relation the spermaceti whale, whose enormous head is made buoyant by its special deposit of oil, and that of the other by the vast space it encloses. They must have been almost constantly on the surface, if they had not been provided with a receptacle for aerated blood.

One may set the whale, or a caterpillar's trachea—which the highest mechanical art could never reach, against the butterflies of the Amazon, alluded to by the President of the British Association. "which, although totally different in structure from the *Heliconideæ*, mimic their colour and mode of flight." Amongst our own

Lepidoptera and *Diptera*, furnished with ocilli, are to be found species closely resembling the stinging *Hymenoptera*, and we may agree with him "that the obvious benefit is safety." In the Pipe-fishes we find some species of which the male is a true pater-familias, for he opens the folds of his long white waistcoat, not to take in turtle or other delicacies of the sea, but to shelter (and probably nourish) his young fry.—I have found his pocket lined, not with silk, but with a highly vascular tissue. Some recently discovered fishes hold their ova in their mouths for protection. Some species of Ray are provided with prickly tubercles, others with a dangerous weapon on the tail, and a few with large peculiar organs which, as in some fresh-water fishes of a remote order, give shocks which not only benumb their prey, but probably prepare them for more easy digestion, as required by the extreme shortness of the alimentary canal. In the great Order of ruminants, with a general resemblance in the stomach and molar teeth, how different are the feet of such a genus as that of the camel, whilst the hog, although it has a divided hoof, differs from the ruminant in its teeth and stomach.

Design, and not mere continuity or selection, might be illustrated by innumerable instances, such as the dentition of the elephant, and the characteristics of the Aye-aye and the ant-eater, so admirably pointed out by Professor Owen, without recurring to the weighty metaphysical proofs of it,—on the passions, affections, instincts, volition, and powers of comparison and memory of the animal creation.

But, how is this continuity (separated from design) to be extended to other planets? To have furnished each of the twenty millions of stars (to say nothing of their probably numerous satellites) with only one rudimentary form would have required the creation of numbers greatly exceeding that of all the known fossil and recent species of plants and animals on this Earth. There is a known identity of some of its elements with some found to exist in the stars; their orbits and solid forms must all be in sections of a cone; nor can we conceive any material beings capable of locomotion on a firm surface, without limbs, or other organs attached to a central medium of union. Goethe (the great morphologist)

says, "where knowledge falls short, or appears inadequate, we must not contest with Faith, its rights. How useful, then, to turn from bewildering speculations as to what might have been accomplished in the creation without an ever-present Deity, to "that Sacred Poetry" which Canon Stanley says "was to be the delight and support of the human soul in all regions of the world," and to read, in the words of the inspired Psalmist, an epitome of some epochs in the world's history;—"The earth, O Lord, is full of thy riches. So is this great and wide sea, wherein are things creeping innumerable, both small and great beasts. These wait all upon thee; that thou mayest give them their meat in due season. Thou openest thine hand, they are filled with good. Thou hidest thy face, they are troubled; they die, and return to their dust. Thou sendest forth thy Spirit, they are created, and thou renewest the face of the earth."

THE FIFTY-THIRD ANNUAL REPORT OF THE COUNCIL.

YOUR Council, in presenting the Fifty-second Annual Report to the Society, has great pleasure in congratulating its members on the near completion of the new Building, which, in every respect, is not only worthy of the fine collection of minerals around us, but worthy of the Society and its founders:—the Architect reports that the Museum will be ready to receive the cases early in the spring, and strenuous efforts should be made by the friends of the Society to make up the deficiency on the building-fund, which is about £500, before taking possession.

The Council has met several times during the past year on business more particularly connected with the Building, than with the scientific part of its duties, which may be thus summarised:—

It has made arrangements to insure the Building in the sum of £1,000.

A very desirable change in the glazing has been made by substituting plate-glass for sheet-glass in the southern front, at an extra cost of £32.

A letter was received from the secretary of the Public Buildings Company, asking this Society to join them in putting in a warming apparatus, so that the whole of the buildings might be warmed from one source; this your Council did not think expedient to adopt.

There being in August last a sum of £300 due to the contractors, your Council authorized your treasurer to make some arrangement for obtaining the necessary amount.

The Council has now the pleasure of laying the Deeds of Conveyance before you duly executed, and take this opportunity of

again recording the obligation this Society is under to Miss Elizabeth Carne, who has thus so munificently handed us the conveyance of the freehold, free of expense. Your Council suggests that a suitable Memorial should be placed in the new museum, expressive of our thanks for the gift, and to record the circumstance under which she was induced to give the site: namely,—"That it should be as a memorial of her late father, Joseph Carne, Esq., a gentleman to whom our Museum and Transactions are so largely indebted," and who for a number of years acted as our treasurer.

Acting on the suggestion of your late Council, the curator, Dr. Le Neve Foster has been engaged during the past year re-arranging and classifying the minerals and fossils preparatory to their removal: many specimens are found to be damaged, and for the first time for many years your Council appeals to all the members and friends of the Society to again contribute geological and mineralogical specimens from the county and various other places, not only for the purpose of replacing those that are damaged of our own collection, but that we shall soon have sufficient space for specimens to show at a glance to the student or visitor an outline of general Geology.

Dr. Foster gave a very interesting Lecture in this room on Geology, but a misapprehension of the present rules prevented a larger attendance of the general public: it is to be hoped that the new rules now submitted by your secretary will receive a more liberal construction, and render these lectures in future popular and useful.

Your Council is convinced that a regular course of Lectures on the sciences of Geology and Mineralogy would be beneficial to the Society, and as financial considerations alone prevent this scheme from being carried out your Council recommends that a sum of not less than £10 be now placed at the disposal of the new Council to carry out the suggestions of the last Report.

The 48th, 49th and 50th Annual Reports, completing the 7th volume, have been sent to the members and the different Societies exchanging their Transactions with us. The respected compiler of the 8th volume of our Transactions reports that it has reached the

15th Table and 474th page. Unless some unforeseen circumstance prevent it will be in the hands of Members soon after our next anniversary.

The Council has regret in announcing the death of two of the original members of this Society and one of its corresponding members.

Colonel Scobell, if not indeed the most zealous co-operator with Dr. Paris in founding the Society, always warmly interested himself in its welfare; he was often a member of the council, several times a vice-president, and occasionally presided at our meetings, he was perhaps the first in Cornwall to take advantage of the science of geology in connexion with agriculture, and his success in reclaiming the waste lands on his large estates may be attributed to this circumstance.

Mr. Rule, another original member of the society, was the eldest son of a manager of *Dolcoath*, and thus became from his youth conversant with metalliferous deposits and with mining; one of his earliest undertakings was a survey of *Dolcoath:* and the Plan and Sections then made furnished Mr. Jordan at a later period with the information requisite for the construction of his beautiful model which now adorns the museum in Jermyn Street, and supplied Sir Henry De la Beche with illustrations which form, to practical men at least, the most interesting part of his "Report on the Geology of Cornwall, Devon, and West Somerset."

About the year 1825 the celebrated Silver Mines of *Real del Monte* in Mexico came into possession of English capitalists, and Mr. Rule was appointed resident superintendent, an office of which he discharged the arduous duties for many years with singular zeal and ability: our first and seventh volumes are enriched by his pen, and the museum owes many choice specimens to his liberality: he frequently sat in our council, and was at the time of his death a vice-president of the Society.

Mr. Percival Norton Johnson, F.R.S., F.G.S., was the only corresponding member of the Society who contributed to our Building-fund. He was distinguished for his acquaintance with geology, mineralogy, and chemistry, and was for many years the

most considerable refiner of the precious metals in the kingdom. Although he had retired from active life for some time, he continued to devote himself to his favourite pursuits and some of his researches will be found in our forthcoming volumes.

The Council has great pleasure in stating that the Treasurer reports that Mr. Le Grice, Mr. Bolitho, The Rev. M. N. Peters, and himself had kindly consented to advance as a loan, without interest, the sum of £200 on account of the Building-fund; it is to be hoped other gentlemen will now come forward to make up the required amount.

SAML. HIGGS, JR.
Hon. Secretary.

Penzance,
5th October, 1866.

CURATOR'S REPORT.

My first endeavour on entering upon the duties of Curator was to ascertain the nature of the collections; but unfortunately in the case of the minerals and fossils I was unable to find any catalogue. After a long but unsuccessful search for the catalogue of minerals, which from the numbers and letters on many of the trays must have existed at one time, I have begun a new one. I have adopted the arrangement used by Mr. Warington Smyth, which, though less truly scientific than the purely chemical classification of Berzelius adopted in the British Museum, is nevertheless far more convenient for the miner, smelter, and practical man. It also has the advantage that it does not differ very materially from the present arrangement. I regret exceedingly that the old catalogue has disappeared so mysteriously, for without it I am unable to ascertain the localities of many of the non-metallic minerals. Luckily in the case of the metallic minerals the names of the donors and the localities are for the most part written on the labels fixed to the trays.

My duties have not allowed my devoting so much time to the catalogue as I could have desired; but little has at present been done, and I fear that it will not be finished before the completion of the new Rooms.

The following Donations to the Museum have been received since the last Meeting:—

Name.	Locality.	Donor.
1. Fossil wood	Egypt	Dr. H. Nankivell.
2. Tinstone and chlorite	West Great Work, Breage	Captain E. Hosking.
3. Bog iron-ore	Pevensey Level ..	C. Le Neve Foster.
4. Spathose iron.....	Lower St. Columb-Porth	
5. Domite (a trachytic lava) ...	Puy Chopine, near Clermont, France	
6. Stalactitic mercadite	Crane Mine, Camborne	
7. Langite	Carn Brea Mines, Redruth	

CLEMENT LE NEVE FOSTER.

Helston,
3rd October, 1866.

TREASURER'S ACCOUNT.

INCOME.	£	s.	d.
To petty Cash		12	7
Donation from His Royal Highness the Prince of Wales	20	0	0
Ordinary Subscriptions and Arrears	64	6	0
Rent of News Room	7	7	0
Executors of J. Rule, Esq., to replace missing volume of Transactions	1	0	0
Balance forward	19	15	0
	£113	0	7

EXPENDITURE.	£	s.	d.
By Balance forward	9	17	5
Rent, Rates, and Taxes	46	11	5
Housekeeper, &c.	5	16	10
Repairs, &c.	2	15	1
Coals	3	1	0
Insurance	2	8	6
Advertising	2	14	0
Printing, Stationery, &c.	34	16	4
Expenses per Treasurer and Secretary	2	17	0
Kinsman's Bill	1	0	0
Petty Cash in hand	1	3	0
	£113	0	7

ROYAL

Geological Society of Cornwall.

FIFTY-FOURTH

ANNUAL REPORT

OF THE COUNCIL,

WITH

THE PRESIDENT'S ADDRESS,

THE CURATOR'S REPORT,

AND

PAPERS AND NOTICES

READ TO THE SOCIETY.

PENZANCE:

PRINTED BY W. CORNISH, BOOKSELLER AND STATIONER.

1867.

(Mr C Fox)

PRESIDENT'S ADDRESS.

On assembling for the first time in this noble room, so well adapted for the practical exhibition of your copious materials for the illustration of geology and mineralogy, the members of this Society may be congratulated on having attained, after an existence of fifty-four years, a local habitation more befitting their purposes and name. Without the energy and liberality of ladies and gentlemen in this neighbourhood, we might still have been lingering on the threshold of this building, which fairly fulfils the first aim in architecture, which is "to devise perfect convenience, clothed in unaffected grace." One member of a family always identified with your progress, Miss Caroline Carne, has inaugurated your entrance into it with the generous gift of £100. Amongst its appliances are convenient laboratories, without which geology, as well as mineralogy, halt in their work. If the diligent chemical examination of rocks and metalliferous compounds be carried on in them, whilst an ample scientific library and a large collection are within reach under the same roof, this place may become yet more attractive to those who desire to continue this course of study amidst scenery which charms, and a climate favourable to health, in this Lusitanian region of E. H. Forbes, rich in the fauna and flora of the south.

Our late president, in his address six years ago, reminded us that the large and valuable collection, containing a great number of rare specimens, required a suitable building for its proper arrangement and protection; and that there were then no less than 6,000 Devonian fossils, presented principally by our late treasurer, and many carboniferous and Silurian fossils, all shut up in drawers (as Professor Sedgewick advised), to preserve them from injury. Then you have also an excellent mineralogical collection, and a

large illustrative series of rocks, especially granite. When those rocks and fossils are exhibited with their names and localities attached, they cannot fail to instruct the student, and awaken in others not a mere love of collecting specimens, but a delight in a new, useful, and healthful pursuit, abroad as well as at home, and in a thorough exploration of our picturesque coast and lovely valleys. How few can recognise rocks by any description alone, or the traces of fossils at first sight, or know where to seek them. Not many can so discriminate a fossil as to point out at once in what formation it might be found; but the great fossil facies of each marked geological division will soon make an impression on the observing mind. The Silurian fossils found 17,000 feet high in the Himalaya (which Salter says are all of new species) agree in general character with those of Europe; and although only 179 species are found both among the 3,145 American and the 4,525 European Silurians, yet they testify in both regions to an existence passed under like conditions, whether in the same horizon or not. The sudden appearance of 900 species of many classes in Barrande's primordial zone indicate that a gap has to be supplied,—that there was a great change in the conditions of life, or a migration from another centre of, or a new, creation. How much remains to be examined, not to solve, but throw light on such great questions. Perhaps it ought to be observed that J. B. Jukes, the able geological surveyor of Ireland, would qualify "the chronological significance of organic remains as being secondary and depending alone, either directly or indirectly, on the stratigraphical succession of the beds in which they occur." On the other hand, how definite the boundaries sometimes are; none of the coal plants of the Alps are found in the Liassic period; or, as Professor Hamilton observed, "reptiles commence with the carboniferous era, not in vague forms derived from others, but in a great variety of new forms, varying in different hemispheres, but with peculiar characteristics." Shall we ever reach, in beds deeper than the Laurentian gneiss (itself the remnant, probably, of altered strata with eozoa), those sources of carbon, which, in the form of carbonic acid, has ever been rising to the surface of the earth, or,

chemically combined, forming a part of its crust, or as graphite, as it is now quarried in enormous blocks in the United States? A geological collection, with its crabbed names, appears dry and uninteresting, unless studied as the grammar and lexicon enabling us to read the leaves of the glorious book of nature, disarranged as they may now be. Much remains to be done before great gaps between these leaves can be filled up, if they do not mark new eras of creation.

But whilst we look with pleasure on the enlarged field for scientific observation and research which this hall will present, and rejoice at our exit from the "interlunar cave" in which we have so long dwelt, we cannot forget the many distinguished men who from time to time lighted it up, and left enduring record of what they achieved in the cause of science, when geology was in its infancy, and they had to grope their way not only in a region, without guide-posts, but devoid also of beaten paths.

The Report to be presented to you record the names of some of your members taken from us since our last annual meeting. Among these was Percival Norton Johnson, who was intimately connected with mining pursuits in this county. He has benefitted his country by his accurate observation and most careful experimental researches. Having examined on the continent the then crude method of preparing German silver, he improved on it so much as to lay the foundation of its now large and beautiful application. He was an early master in the art of utilizing Platinum, of which he made the largest sheet; and as an analytical metallurgist he was the highest in his profession. Ashurst Majendie was one of the founders of this Society, and as far back as 1814 contributed valuable papers to our Society's Transactions. His observations on our serpentine rocks have never been fully supplemented in this county, as Sir Humphry Davy urged should be done. Ashurst Majendie was one of the earliest geologists who remarked on the intrusive character of granite, and on its not preceding the sedimentary strata.

At the inauguration of this hall I observed that the British Association was at the time engaged in probing the granite rocks.

That conclave of experienced geologists shows that there is much to be done in reference to this important member of the porphyritic series of rocks. Professor Ansted remarked "that the book of investigation was not completed when granite was reached, and that there was just as much to observe and read in making out the history and age of the granite, as in determining the geological position of a fossiliferous limestone."

Professor Phillips thought that the enquiries which had been going on would require to be prosecuted to a much larger extent, before they could arrive at anything like a satisfactory conclusion on the subject, on which there was such a diversity of opinion, and also to have a more accurate impression of what is the proper meaning of "Granite." Sir H. De la Beche having called the dykes which traverse Kynance sands and those of Kennech cove, "granite," is an instance of the wide range which some geologists would give to the term. I remember with what interest I traversed, many years ago, the Isle of Arran, with its lofty granitic peak of Goatfell, and looked at its old red sandstone and schist. Dr. J. Bryce has renewed his examination of the island, and has changed his conclusion as to the relative ages of the fine and coarse grained granites; the latter he believes to be overlaid by the former. Dr. Bryce's companion in his researches (E. A. Wünsch), on the contrary, thinks that they are of the same age, and that the difference was owing to that of the texture of the strata previous to their metamorphosis. We shall not all be easily convinced that varieties in grain necessarily indicate different ages, whether we agree with Professor Ansted or not, that all granite has been elaborated from stratified rocks with water under great pressure, and at a temperature below melting heat. By a section in the Island of Corsica, which he has recently examined, he illustrates his views that granite is an altered stratified rock, and that whether it is to to be called an erupted rock or not, depends on the meaning assigned to the term. One may reasonably doubt if the lofty peak of Goatfell were metamorphosed *in situ*, and afterwards denuded of the strata to which it owed its origin, not merely because it is more recent than the schist, into which it sends veins, and has

broken through it within a few yards of the old red sandstone; but incontrovertibly so, from the fact that in Arran, as described by C. A. Wünsch, he found in the beds of trappean ash, tilted up by the granitic nucleus at an angle of 37 degrees, stems of trees (some of them *Sigillaria*) at right angles to the stratification; the hollow of one trunk was filled up with vegetable *débris* and fir cones. The various sections of granite in this country, which are exposed in cliffs and in mines, claim the attention of this society to the structure, chemical nature, and position of that rock. Is it not probable that an extensive survey of our mineral veins within a few fathoms of the surface, could inform us as to the relative period of their formation, whether before or since the hills assumed their present form by denudation or otherwise, not judging merely from the upper gossan, from which the sulphur of the pyrites might have been eliminated after denudation had removed the strata above them, but from the presence of other minerals, such as tin, blende, &c., which were much less likely to have undergone similar changes, but are found principally in the upper parts of the vein? the frequent occurrence of metalliferous veins which do not reach the surface tends to confirm this view. If there had been an enormous denudation of the granite, should we not find in addition to the deposits of its granite in the valleys a more frequent cccurrence of boulders of it lying on the circumferent schistose rocks?

Standing opposite to the lofty and isolated granite peak of the Maladetta (the highest of the Pyrenees), and seeing that the sedimentary and crystallized rocks are tilted up at a high angle by other granite masses, the impression is most strong that they were not altered *in situ*. Recent experiments made by Adelund on the expansion of metals by electrical currents independently of heat) may throw light on the contraction or expansion of rocks, in which there were no manifest traces of a high temperature.

Your new laboratory will afford facilities for such chemical examination of the various granites and other porphyritic rocks as has been commenced in Ireland; it is not only of importance with reference to our special objects, but also to mining and agriculture.

M. Daubrèe has found that the reduction of felspar to a fine powder does not enable water to dissolve its potash, but that 2 per cent. are taken up by water by its action on fragments violently agitated. Potash forms a larger part of our cereal crops than any other mineral except silex, but, when fast bound by chemical combination, lies dormant in the soil.

The confessedly igneous rocks should also be included in your chemical examination. The President (A. Geike) of the Geological Section of the British Association, in his luminous address to it, at Dundee, on the volcanic rocks of Scotland, says that it is a field of research in British geology in which much remains to be discovered, where the labourers are but few. "The same vague names, the same confused arrangement, the same absence of careful chemical and mineralogical analysis, still disfigure our geological writings and collections, as in the infancy of the science. It will require the labour of the geologist skilled to glean the data that can only be gathered in the field, and of the chemist who, aided and guided by these observations, shall seek to determine the composition of the different igneous rocks, and the relation which they bear to those of other regions, and of modern volcanoes." In the neighbourhood of Padstow especially, and in the carboniferous series of East Cornwall, there is much to be enquired into. A. Geake considers that the trappean ash and crystallized amygdaloidal greenstone at the base of that series belongs to the age of the old red sandstone. He seems skilfully to rake out the slag and ashes of the old fires, and to show how they raged first, in the lower Silurian, as in Cader Idris, and afterwards in the Snowdon district. He attributes the massive sheets of felstone to lava flowing under the pressure of the sea, which also covered the volcanic dust and stones mixed with sediment, and shells, corals, &c. In Scotland volcanic action seems to have been continuous through the whole of the old red sandstone period, and extending through the Ochil and Sidlaw hills for 60 or 70 miles, and in the Pentland hills, reaching a thickness of 5,000 feet. West of Stirling may be seen in terraced heights of igneous rocks, how unslaked was the fire in the carboniferous period. *Primâ facie* what collier would have

sunk 100 fathoms through volcanic tuff to reach the black band ironstone, if geology had not shown that it was a volcanic product erupted through the coal without destroying it. A. Geike is not aware that there is any evidence (except in the new red sandstone round Exeter) of volcanoes in the British Islands, between the old red and the tertiary period. Northwards through Antrim, the inner Hebrides, Faroe to Iceland, the volcanic masses are assigned by him to the miocene period, to which Pengelly and Heer assign the subtropical vegetation of the southern slope of Dartmoor. And in Mull basaltic rocks, 3,000 feet in thickness, have miocene plants at their base. It was in this island that the Duke of Argyle observed the granite mountains. Ben Craig, one of the lower shoulders of Ben More, gradually peeping upwards into a rock, looks like a mass of tuff, weathered and bleached and much shattered, but is really trap; the summit peak is of mica slate. A. Geike points out the difference between the igneous rocks contemporaneous with the carboniferous beds and those of later date; the former are principally highly felspathic, under the names of compact felspar, porphyry, hornstone, &c. To the later period belong the augitic rocks, such as basalts and dolerites, or greenstones (as they are called in Scotland). He concludes that the study of the igneous rocks of Britain affords no proof that volcanic action has been slowly diminishing in force during past geological time. A. Geike's observation on the thousands of trap dykes which traverse the north-west of Great Britain (which he also refers to the tertiary period) are of great interest. Although not coming through lines of fault, they preserve a straight course with well defined walls through irregular strata and through large faults without deviation. He argues that if the trap itself had been the disrupting agent, it would have risen through the older fractures. R. Tate has recently alluded to a band of igneous rocks extending across South Africa, separating and lying conformably with some of the Karoo beds which participate in the foldings of the (probably) Devonian districts of the Zuernberg. The volcanic island of Mauritius is another illustration of Darwin's views as to the bases of coral reefs in the Pacific. Masses of coral, forty to fifty tons in

weight (not of a species now found there living), lie 50 feet above the level of the sea, but at 900 feet high there is a large quantity of coral of species still existing in the ocean, which would seem to indicate great changes of vertical movements. Does not the soft aluminous hill, 1,000 feet high, near the Grand Port district, formed entirely of hexagonal prisms, from one to five feet in diameter, appear to have been poured out beneath the sea?

If the temperature of the earth had been much lowered during the immeasurable time between the early palæozoic rocks and those of the tertiary period, is it not probable that volcanic action would have lessened, whether that proceeds from chemical combination, or from the presence of intensely heated matter? We may conclude from Fourier's mathematical theory of heat, that the volume of the earth may not have been visibly diminished, and that the temperature on its surface might vary under solar influences consistently with the intense heat in depth, if we can discover that the temperature increases downwards. Schlagintweit found the temperature of a spring at Mounkam in the Himalaya to be 202° at an elevation of 5,587 feet above the sea, and that of another 105° in the Sikkan, in the same locality, 16,000 feet high. The enquiry now carried on by the British Association may throw further light on the rate of increase. On this point conclusions may be erroneous, if there is an omission in observing what obstacles or facilities the strata (especially the horizontal ones) present for the passage of heated vapour from below. The earliest contributor to your Transactions on this subject, R. W. Fox, has requested that a thermometer may be placed down on the rock of the Mont Cenis tunnel, to obtain some data as to the curve of an isothermal line supposed to rise into the heart of the mountain, where it is at a great elevation above the level of the sea.

Whether serpentine should be included with the igneous rocks is a question on which our leading geologists differ; its expanse in the Lizard peninsula, and its existence in at least three other parts of this county, and the large development of the allied hornblendic rocks, offer a field for further enquiry, and at the same time should give it a greater interest in our eyes. The very experienced

president of the Geological Society of London observes that the geological surveyors of Canada believe that the serpentine, as well as the crystallized limestones amongst the gnarled and contorted beds of micaceous schist and gneiss of their own district, although altered, are still in their original beds, the joint action of water and a high temperature having forced them under high pressure and in a plastic state among disrupted strata. The serpentine of the Clicker Tor, near Liskeard, and the adjacent schist, certainly do not give me the idea of a rock erupted in a state of fusion: unvarying lithologically wherever it is visible, it seems not to have altered the slate-rocks which surround it (as may be seen from the specimens) within a few feet of the serpentine. This hard rock probably stopped the rich lead-veins of Menheniot, and narrowed the valley of Coldrennick.

In the Lizard district, where there seems to be so intimate a connection between the hornblendic diallage, and serpentine rocks, and such an altered condition of the schistose rocks (especially eastward towards Helford harbour), it is natural to look on them as erupted in a fused state, as the Italian geologists conclude was the case with some of the serpentine of Tuscany. The great relation of the magnesian rocks of the Lizard and the deposit of rounded quartz pebbles on a part of it, may indicate that they were formed beneath the surface of the ocean. The tilting up of the great rocks of (old) red sandstone conglomerate or breccia of the Nare headland seems to me to have been contemporaneous. I do not discover, in this conglomerate, a morsel of the adjoining serpentine, or granite, of which there are hills of twenty square miles in extent only three miles distant, but cut off by an inlet of the sea. If some of our granites are more recent than the carboniferous beds into which they send veins, so also must be many of the hornblendic greenstone bands, having the general east and west direction of the granite bosses and curving round them, and not found in the carboniferous district, except in the proximity of the granite. In Turkey, as pointed out by Mr. Boué, eocene beds are, in many places, pierced by serpentine, diorite, and metalliferous porphyries. W. W. Smyth says that it is not

improbable that the hydrated silicate of magnesia of the serpentine rocks may be produced by various decompositions, but that if it were conceded that serpentine has been transmuted from a rock of Labradorite and diallage, or of anorthic felspar and hornblende (diorites), we then pass back to compounds more akin to the confessedly igneous rocks, making it more difficult to derive them from sedimentary rocks. He dwelt the more on these substances because, as he remarked, recent investigations respecting them have invested them with a special interest, for it has been shown that they are connected with telluric and even cosmical phenomena on a nobler scale than had been anticipated by many geologists. "Telluric," since M. Daubrèe by his synthetical experiments on meteorites, has started a fresh enquiry into the nature and origin of the silicated magnesian rocks. Blumenbach had shewn, years ago, that meteoric stones contained few substances not found in dolerite. M. Daubrèe by melting down olivine, hypersthene, basalt, &c., imitated siderolites. Olivine and bisilicate of magnesia were easily melted at a temperature not above red heat, the result being a crystallized substance resembling the original rock. Ordinary volcanic products, especially these, contain more magnesia and are far more fusible than olivine, of which they bring up angular fragments, as if broken off from a deeply seated mass. M. Daubrèe infers that peridotic (olivine) rocks predominate at a certain depth, and he would comprise them with the serpentines, as the peridotic family or cosmical rocks. Olivine and enstatic (bisilicate of magnesia) crystallize after simple fusion, which aluminous silicates do not. Daubrèe connects the high density of olivine, being nearly a quarter greater than that of granite, with its greater depth of position below the surface. He suggests that the peridote rocks, after acquiring water at a great depth, were protruded as serpentine. W. W. Smyth observes that the great readiness with which the melted substance of serpentine was transformed into less basic silicates, seems to account for the frequent association of these rocks with greenstones, euphotide, &c. The serpentine of Clickerton yields but little asbestus in comparison with the crystallized greenstone of St. Cleer in the same district.

W. W. Smyth has pointed out in a very lucid manner the analogy between meteorities and fused serpentine, from which grains of iron containing nickel may be separated. In the Ural region, serpentine has been found encrusting platinum, as well as chromate of iron. But the minerals similar to the material of our stratified rocks are absent from meteorities, pure silex with one exception never having been found in them. He further asks, if this may not be accounted for by the apparent fact that the crystallization, especially of the felspar group, has not been accomplished by simple fusion, but has needed other agents such as water. Geologists may fairly lay claim to aerolites, as they are sometimes distributed in a single shower over an area of thirty and even ninety square miles; and Professor Herschel mentions one which fell at Kuxatunna, in Hungary, on the 9th of June, last year, scattering one thousand stones, one weighing six cwts., over an area of forty miles. Tin, copper, lead, as well as nickel, are found in some of them, as if a mining scheme had exploded when whirled into space. Professor Adams told me in December last, that he was engaged in calculating the orbit of the last November shower, and that he believed it to have a period of thirty-three years. The result is well known. Having determined its radiant point and calculated the influence of Jupiter, Saturn, and Uranus, to be 28′ on the longitude of the node in 33–35 years, whilst the observed increase in that time is 29′; he cannot doubt that their period is 33¼ years, with a mean distance of 10·34, eccentricity 0·9047, perihelion distance 9856, and an inclination of its retrogade orbit 17°, agreeing in other elements of their orbit with those of Tempel's comet of last year, whilst the course of the August meteors is shewn by S. Schiaparelli to agree with that of the great comet of 1862.

At the various intervals during nearly a thousand years, at which the appearance of this shower, 6000 miles wide (and fiery when it approaches our earth), has been recorded, each small fragment, even of a few grains in weight, has observed the laws to which the Supreme has subjected the Universe. Mr. Higgins found that the nucleus of Tempel's comet gave in the spectroscope

a blue light, and the surrounding envelope the reflected light of the sun, and also that a blue ray proceeded from some of the meteors of November.

The broad claymore of the Campbells no longer flashes in civil war; their chieftain wields his powerful pen in defence of the reign of law in the hand of the Omnipotent legislator. The most able exposition of it must be necessarily incomplete in marking design in all the phenomena of nature, whilst, as A. W. Wallace says,—"we know an infinitesimal fraction of its past history." This accomplished traveller and naturalist has lately grouped together many facts which show the relation between the colours of the two sexes in birds, and their nidification in places either open or hidden; and that where both sexes are of bright colours, the nest conceals the sitting bird, but where the nests are exposed the females are devoid of the bright plumage of their partners. The blue and crimson chatterers, the tropical flycatcher, in which the females are of earthy-brown or olive-green tints, are instances of the latter class. Entire families of birds, such as toucans, parrots, and woodpeckers, make their nests in holes deep in the earth, or in the trunks of trees; others, a roofed or a hanging nest: in all these families the females, whilst sitting, would by their colours betray their presence to their enemies. A. W. Wallace sees in these beautiful provisions "the long-continued actions and reactions of all known and unknown causes, which must have been in the highest degree complex." Does this explanation satisfy us? I think not. The great mathematician, Le Place, has shown how many million of probabilities there are against the present movements of the planets and their satellites not being the result of design. Does not this apply in a vastly greater ratio to the correlation between habits and structure of every one of the innumerable species of birds alluded to by Wallace?

But, is there anything improbable or at variance with physiology, in the belief that at the creation of each typical irrational animal with a special structure adapted to the circle of existence in which it was adapted to move, its nervous centre received from the plastic hand of the Omnipotent such a vital impression, as to the

special employment of its organs, as might be transmitted to all its progeny, and become an hereditary experience or rather instinct, as some name it (as may be daily observed amongst men to a limited extent)?—Such innate experience or instinct as is found in the beaver,—the nidification of birds,—in the habits of parasitical insects, as ichneumons and the gadfly, the latter glueing its eggs only to those parts of the horse's skin that his tongue can reach. A great sensibility to external influences, varying in animals, both in intensity and kind, may of course modify their habits.

The committee of exploration of Kent's Cavern have made a further report to the British Association of results obtained similar to preceding ones. In one part the black earth was partially covered by stalagmite. In this stalagmite were found parts of a human jaw, with four teeth, charcoal, and flint flakes. The portion of the black band of earth belew it contained bones of the ox, deer, horse, bear, cave hyæna, and rhinoceros tichorinus; with flint and bone implements, including a comb, an amber bead, and a harpoon barbed on one side. In the red loam under, bones of the mammoth, cave lion, with many flakes of flint. The bead of amber, as well as similar beads of glass, found with bone implements, bronze, and iron, in Celtic caves in county Meath, are evidences of intercourse with foreigners. Capt. Brome's report of his examination of a cave in the limestone of Gibraltar, 700 feet above the sea, shows that it has been a fruitful one. Dark earth, to the depth of two to six feet, covered the stalagmite floor, on which were deposited bones of animals not extinct, pottery, stone axes, and flint implements. Capt. Brome's son found two ancient swords, one partially embedded in the stalagmite—both were much injured—and a small enamelled copper plate, of beautiful colours, on which was the design of a bird in the coil of a serpent. In St. Michael's Cave he found numerous human remains, some embedded in the stalagmite, others loose, associated with stone axes and flint implements of the smallest size. From the short notices of these Gibraltar caverns, one might conclude that they contain osseous breccia like that of the Oreston quarries described by William Pengelly. When I was

at St. Michael's Cave at Gibraltar long ago, I little imagined what a store of objects of interest lay concealed there.*

Dr. Tyndall, who has most clearly illustrated the physical phenomena of heat, light, and sound, warns us against enquiring into the "deep and inaudible mysteries of creative power," but would he not confine our conceptions within the limits of a positive philosophy? He compares "the mind of man to a musical instrument which has only a certain range of notes, beyond which, on either side, there is an infinitude of silence." May I not add, yes, a deathlike silence, if the breath of Heaven do not blow from the four winds, and breathe on the dry bones, raising them to a higher life, and giving them to hear the divine harmony, and to join in it

With preamble sweet
Of charming symphonies.

---

* A. Tylor has recently brought evidence to show that the gravel containing flint implements, in the valley of the Somme, is of the same age as Sir C. Lyell's new gravel.

THE FIFTY-FOURTH ANNUAL REPORT OF THE COUNCIL.

At the last Annual Meeting your Council pledged itself to hold this Meeting in the new building, and has so far been enabled to do so by meeting you in this noble room to-day. Conjointly with the Corporation and the Penzance Buildings Company, with whom your Council and its Building Committee have worked most harmoniously, this building was formally opened by the President on Tuesday, the 10th September last. The scene of the opening ceremonial in St. John's Hall was one not likely to be forgotten by those who had the opportunity of being present; and your Council can only reiterate the sentiments of the speakers on that occasion, "That, not only might this Society continue to flourish, but that whether it be for the enjoyment of the lectures, the solution of some problem of science, or the contemplation of some masterpiece of art, we shall learn to abandon prejudices, to appreciate each other's merits, and to foster in ourselves and in our neighbours the love of all that is good, beautiful, and true." Your Council considers it will not now be out of place to mention the active part this Society has taken in bringing about the building of this noble edifice. At the Annual Meeting of 1841, the following resolution was passed:—"that it would be most desirable, for the sake of economy, for this Society to unite with other institutions in this place in the erection of one large building, which should include the Natural History Society, the Savings' Bank, and other establishments; and that this Society might go as far as £1,000 for such portion of the buildings as would be necessary for the Museum and other apartments." The Council and officers of the Society have never lost sight of this desirable proposition,—but the difficulties natural to such a scheme were such that little progress was made

until September, 1850, when, under the presidency of our munificent and respected member, Sir Charles Lemon, the first effort was made by this Society to obtain the present site, and our architect, Mr. Matthews, was instructed to prepare plans on an estimate not exceeding £2,000, provided the ground could be obtained on advantageous terms. The difficulties in obtaining the site were so great and tedious that in 1860 the Society began to despair of ever obtaining it, and looked about for another, with a view of building on its own account. Whether or not it was owing to this determined spirit it is difficult to say,—but the other societies, backed up by a Public Buildings Company, began again to bestir themselves; and from their united efforts have resulted this magnificent block of buildings. Your Council would impress these circumstances on the minds of the members of this Society, in order that publicity might be given to them, as it thinks they would have weight with the public, and materially assist the earnest appeal made by the President for funds, and enable the new Museum belonging to this Society to start free from encumbrance. It is not the intention of your Council to enter on this occasion into financial matters, a special report of which will be presented by your Treasurer; but it deems it right to mention the munificence of the Misses Carne, who contributed—the one the site, and the other £100 towards the building-fund. The Society is also under deep obligation to the High Sheriff—D. P. Le Grice, Esq., the Rev. M. N. Peters, and the Treasurer, who, in addition to their subscriptions to the building-fund, have, as occasion required, held themselves responsible for a portion of the moneys falling due.

In accordance with the resolutions passed at the last meeting, your Secretary made arrangements for a course of lectures during the winter season, and had arranged for six, four of which were given by Mr. Waterhouse Hawkens, and with marked success. The Council has pleasure in announcing that arrangements have been made for a continuance of these lectures—not only by this eminent professor, but from the old and tried friend of the Society, William Pengelly, Esq., Torquay. Your Council feels satisfied from the results of the first two years, that a periodical course of

lectures will be beneficial to the Society; and it further ventures to express to this meeting its opinion that its treasures, resources, and valuable laboratory might be made available under certain conditions to the Miners' Association, &c.

It is satisfactory to note the considerable increase in the number of members during the past five years, but sad to see, as year by year goes by, the old names passing from us. In the obituary for this year your Council has to record the loss of some of those who were amongst the founders of this Society—the earnest supporters of it in recording the various phenomena of nature that fell under their notice,—and of one who took an active part with us in assisting to carry out the arrangements of the present building. Need it be mentioned that Percival Norton Johnson, Ashurst Majendie, Nicholas Vivian, Samuel Borlase, Henry Lewis Stephens, and James Trembath are taken from us? Let us hope that the intention of the founders of the Society, and its supporters, may in this new building bear fruit which shall to our county yield an increase a hundredfold.

By order,

SAML. HIGGS, Jun.,

Secretary.

CURATOR'S REPORT.

THE Museum has not received any very important additions during the past year, but numerous specimens of minerals and fossils have been offered by Mr. J. Jope Rogers, and will be gladly accepted as soon as the new rooms are fitted for their reception. The minerals include specimens of native copper, malachite, and the iron-ore of Elba, whilst among the fossils are several species of the Ammonite, some good specimens of the fossil ferns of the Coal measures, besides some plaster casts of Trilobites, which will be of much use to students of Palæontology. The following minerals have been lately received:—

NAME.	LOCALITY.	DONOR.
1. Calamine	Sardinia	F. Gordon Davis, Esq.
2. Galena & Zinc-blende, showing a concrete structure	Welkenraedt, Rhenish Prussia	C. Le Neve Foster.
3. Calamine	Altenberg, near Aix la Chapelle	C. Le Neve Foster.
4. Willimite	Altenberg, near Aix la Chapelle	C. Le Neve Foster.
5. Black Calamine...	Welkenraedt	C. Le Neve Foster.
6. Bones of Dinornis	.....	J. Davies Enys, Esq.

CLEMENT LE NEVE FOSTER.

Penzance,
5th Nov., 1867.

LIBRARIAN'S REPORT.

THE Library of the Society remains in its position in the Council Room, at the North Parade, and various parcels of Books and Periodicals have arrived during the past year, and are deposited on the table in the old building, as in former years. The removal of the Library to the new Geological Buildings will have to be carried out at no distant period; and I have to request the appointment of an officer more immediately connected with the Geological branch of Natural History Science, to practically superintend the care of the Library at and subsequently to the removal of the Establishment, in pursuance of the understanding to that effect when I accepted the office of Librarian.

Amongst the works that have been received during the past year are:—

1.—Catalogue of the American Philosophical Society's Library, part II.
2.—Proceedings Amer. Phil. Soc., Vol. X., 1866, No. 76.
3.—Statistics of the Gold-fields of Victoria, 1860, 61, 62.
4.—Mineral Statistics, Victoria, 1864.
5.—Ditto, 1866.
6.—Reports of Mining Surveyors and Registrars, Victoria,—four Quarters of 1866, and 1st Quarter of 1867.
7.—Mounted Map of Victoria, showing Mining Districts and Gold-fields.
8.—Annual Report of Smithsonian Institute for 1865.
9.—Smithsonian Miscellaneous Collections, Vols. VI. and VII.
10.—Annual Report of the Secretary of War, U. S. A., for 1866.

TREASURER'S ACCOUNT.

INCOME.	£	s.	d.
To petty Cash in hand	1	3	0
Donation from His Royal Highness the Prince of Wales	20	0	0
Ordinary Subscriptions and Arrears	87	8	0
Proceeds of Lectures, per Hon. Sec.	1	11	0
Rent of News Room	7	7	0
Balance due to Bankers	17	10	10
	£134	19	10

EXPENDITURE.				£	s.	d.
By Balance forward				19	15	6
Rent, Rates, and Taxes				47	16	7
Housekeeper, &c.				6	5	1
Coals				3	1	0
Expenses, Secretary and Treasurer				6	13	11
Insurance :—						
Ordinary	£2	8	6			
Extraordinary	3	15	0			
				6	3	6
Advertising				4	5	9
Printing, Stationery, &c.				40	15	0
Petty Cash in hand				0	3	6
				£134	19	10

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness.

Her Most Gracious Majesty THE QUEEN.

Vice-Patron.

His Royal Highness the Prince of Wales, K.G.

Trustees.

Thomas S. Bolitho, Esq.
John S. Enys, Esq., F.G.S.
Day P. Le Grice, Esq., M.A.

OFFICERS AND COUNCIL FOR 1867-8.

President.

Hugh Seymour Tremenheere, Esq., M.A., F.G.S.

Vice-Presidents.

John Francis Basset, Esq.
Thos. S. Bolitho, Esq.
Charles Fox, Esq.
Day P. Le Grice, Esq., M.A.

Treasurer.

William Bolitho, jun., Esq.

Secretaries.

S. Higgs, jun., Esq., F.A.S., F.G.S.
John Hallet Batten, Esq., F.R.G.S., M.R.A.S.

Librarians.

Edward Hearle Rodd, Esq.
Rev. John Carne, M.A., F.S.A., F.G.H.S.

Curator.

Clement Le Neve Foster, B.A., D.Sc., F.G.S.

Council.

The Officers of the Society *(members ex-officio)*.

Francis Boase, Esq.
Edward Bolitho, Esq.
Richard Foster Bolitho, Esq.
Richard Boyns, Esq.
Frederick W. Brittain, Esq.
G. M. Millett-Davis, Esq.
John Samuel Enys, Esq., F.G.S.
William Hustler, Esq.
Samuel Higgs, Esq.
Rev. M. N. Peters.
John Jope Rogers, Esq.
John St. Aubyn, Esq., M.P.

LIST OF THE MEMBERS, 1867.

HONORARY MEMBERS.

George James Allman, M.D., F.R.S., Prof. Nat. Hist. University of Edinburgh, M.R.I.A.
L. Elie de Beaumont, Member of the Institute of France, Paris.
Becquerel, Member of the Institute of France, Paris.
Henry S. Boase, M.D., F.R.S., F.G.S., &c., Claverhouse, Dundee.
Ami Boué, M.D., Vienna.
Josiah P. Cooke, Prof. of Chemistry, &c., University of Cambridge, U.S.
John F. Cunningham, F.G.S.
Achille Delesse, Paris.
J. Fournet, Correspondent of the Institute of France, Lyons.
Sir R. J. Griffith, Bart., LL.D., F.R.S., F.G.S., &c., Dublin.
Rev. W. Vernon Harcourt, M.A., F.R.S., &c., Bolton Percy, Tadcaster.
Thomas Hawkins, F.G.S., Whitwell, Isle of Wight.
Sydney Hodges, Torquay.
Sir Charles Lyell, Bart., M.A., D.C.L., LL.D., F.R.S., L.S., & G.S., London.
L. Moissenet, Paris.
Sir Roderick I. Murchison, Bart., K.C.B., G.C. St. S., M.A., D.C.L., F.R.S., L.S., & G.S., &c., London.
Richard Owen, M.D., D.C.L., F.R.S., L.S., & G.S., British Museum.
John Phillips, M.A., LL.D., F.R.S., F.G.S., &c., Oxford.
Lyon Playfair, C.B., Ph. D., F.R.S., &c., Edinburgh.
Constant Prévost, Paris.
Rev. A. Sedgwick, M.A., LL.D., F.R.S., L.S., & G.S., Woodwardian Professor of Geology in the University of Cambridge.
Professor Schœnbein, Basle.
Warington W. Smyth, M.A., F.R.S., Pres. G.S., London.
James Tennant, F.G.S., Professor of Geology in King's College, London.
Nicholas Whitley, Truro.

CORRESPONDING MEMBERS.

Thomas Foster Barham, M.D., Exeter.
W. H. Benson, Aix la Chapelle.
J. Bowman, London.
E. W. Brayley, F.R.S., L.S., & G.S., London.
James Bryce, M.A., LL.D., F.G.S., &c., Glasgow.
Sir P. T. Cautley, K.C.B., F.R.S., &c., Lt.-Col. Bengal Artillery, Member of Council of India.
Jonathan Couch, F.L.S., Polperro.
Rev. Thomas England, F.G.S., &c., North Lew, Devon.
Abraham Gesner, M.D., F.G.S., New York.
Robert Hunt, F.R.S., F.S.S., London.
John Edward Lee, F.S.A., F.G.S., Caerleon, Monmouth.
William Lonsdale, F.G.S., Bath.
Henry Mac Lauchlan, F.G.S., London.
Joseph Parker, jun., F.G.S., Upton Cheyney, Gloucester.
Charles W. Peach, Peterhead.
William Pengelly, F.R.S., F.G.S., Lamorna, Torquay.
Joseph Prestwich, F.R.S., F.G.S., London.
Martyn J. Roberts, F.R.S.E.
Henry Thomas, F.G.S., The Waldrons, Croydon.
G. B. Tremenheere, F.G.S., Major General Bengal Engineers, London.

ORDINARY MEMBERS.

Sir T. Dyke Acland, Bart., F.R.S., F.G.S., &c., Killerton, Devon.
J. F. Basset, Tehidy Park.
John Hallet Batten, F.R.G.S., &c., Alverne Hill.
C. Dacres Bevan, Boskenna.
J. S. Bickford, Tuckingmill.
Henry Blackwell, Penzance.
C. W. Boase, Balgay, Dundee.
Francis Boase, M.R.C.S., Buriton House.
Edward Bolitho, Trewidden.
Thomas Bedford Bolitho, Trewidden.
Thomas S. Bolitho, Penalverne.
William Bolitho, Polwithen.
R. F. Bolitho, Ponsandane.
William Bolitho, jun., Ponsandane.
Walter Borlase, Lariggan.
John Borlase, Marazion House, Marazion.
Edwyn S. Boyns, Penzance.
Richard Boyns, St. Just.
John R. Branwell, Penlee.
F. W. Brittain, Lannoweth.
Rev. John Carne, F.G.S., Merther.
Miss E. C. T. Carne, Penzance.
Thomas Cornish, Penzance.
J. Claude Daubuz, Killiow.
Humphry Davy, Penzance.
R. V. Davy, Penzance.
Richard Davey, M.P., F.G.S., Bochym.
Wm. Horton Davey, Bochym.
Nicholas B. Downing, Penzance.
Earl of Mount Edgcumbe, Mount Edgcumbe.
John S. Enys, F.G.S., Enys.

Clement Le Neve Foster, B.A., D. Sc., F.G.S., London.
Alfred Lloyd Fox, Falmouth.
Robert Were Fox, F.R.S., Penjerrick.
Robert Fox, Falmouth.
Alfred Fox, Glen Durgan.
Charles Fox, Trebah.
Charles F. Giesler, London.
William Glanville, Redruth.
Charles Guy, Penzance.
Richard Harvey, Greenaway, Dartmouth.
C. H. T. Hawkins, Trewithen.
W. J. Henwood.
Samuel Higgs, Penzance.
S. Higgs, jun., F.G.S., F.A.S., Penzance.
Thomas Hollow, Penzance.
William Hustler, Rosemerryn.
John Henry James, Penzance.
Stephen Harvey James, jun., Botallack.
Day P. Le Grice, M.A., Trereife.
Sir Charles Lemon, Bart., F.R.S., F.G.S., &c., Carclew.
J. Mathews, Penzance.
George M. Millett-Davis, Treneere.
J. P. Milton, Penzance.
William Mitchell, Penzance.
S. R. Pattison, F.G.S., London.
H. Paull, M.P., London.
R. Pearce, Swansea.
Rev. M. N. Peters, Bellair.
T. Roxburgh Polwhele, M.A., F.G.S., Polwhele, Truro.
Francis Pryor, Redruth.
K. Macaulay Punnett, London.
Edward Hearle Rodd, Penzance.
J. Jope Rogers, Penrose.
John Roscorla, Penzance.
John St. Aubyn, M.P., St. Michael's Mount.
Rev. Edmund St. Aubyn, Stoke Gabriel.
The Earl of St. Germans, G.C.B., Port Eliot, St. Germans.
H. C. Salmon, F.G.S., F.C.S., London.
Augustus Smith, M.A., F.G.S., Tresco Abbey, Scilly.
George Smith, LL.D., F.S.A., Trevu.
Rev. F. Stephens, Mawgan.
Richard Taylor, F.G.S., London.
William Teague, Tincroft.
Rev. Uriah Tonkin, Uny Lelant.
H. Seymour Tremenheere, M.A., F.G.S., London.
William Trythall, Penzance.
Robert Tweedy, Tregolls.
Louis Vigurs, Rosehill.
Sir Richard R. Vyvyan, Bart., F.R.S., F.G.S., Trelowarren.
Sir William Williams, Bart., Tregullow.
Frederick Martin Williams, M.P., F.G.S., Goonvrea.
John Michael Williams, Carhayes Castle.
George Williams, Scorrier House
Richard White, St. Just.
H. Coulson York, Herbier House.

SECOND-CLASS MEMBERS.

Richard Bain, Burncoose.
James Bennetts, St. Just.
Charles Chorley, Truro.
W. F. Hooper, ditto.
Richard Newton, St. Agnes.
Edward Lavin, Penzance.
S. Michell, Swansea.
John Nancarrow, Camborne.
Richard Newton, jun., St. Agnes.
O. E. Trezise, Redruth.
John Way, jun., Gwennap.

Arundel Anthony, Lelant.
Francis Barratt, St. Blazey.
Thomas Blamey, Gwennap.
John Eddy, Lisburne Mine, Cardiganshire.
William Eddy, Pendeen Consols Mine, St. Just.
— Evans,
John Giles, Sheffield.
William Gregor, Swansea.
R. T. Hall, Devoran.
William Hollow, jun., Lelant.
Richard James, Wheal Margery Mine.
John Lyle, Bonython.
Henry Pascoe, Berehaven Mines, Co. Cork.
John Phillips, Australia.
— Provis, Camborne.
John Richards, Trefula, St. Day.
Stephen Thomas, Redruth.
Thos. Treloar, Marianna, Brazil.
Thomas Treweeke, St. Ives.
Joseph Vivian, ditto.
William Vivian, Mwyndy, Glamorgan.
William White, St. Just United Mines.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

FIFTY-SIXTH, FIFTY-SEVENTH, AND FIFTY-EIGHTH

ANNUAL REPORTS

OF THE COUNCIL,

WITH THE

PRESIDENT'S ADDRESS, TREASURER'S AND LIBRARIAN'S REPORTS,

&c., &c.

PENZANCE:
F. RODDA, GENERAL MACHINE PRINTER, &c., 6, MARKET PLACE.

1872.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

FIFTY-SIXTH ANNUAL REPORT.

PENZANCE.

1869.

QE
262
.C8
A2

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

Her Most Gracious Majesty the QUEEN.

Vice-Patron:

His Royal Highness the Prince of Wales, K.G., &c., &c.

Trustees:

Thomas S. Bolitho, Esq.
John S. Enys, Esq., F.G.S.
Day P. Le Grice, Esq., M.A.

OFFICERS AND COUNCIL FOR 1868-9.

President:

Hugh Seymour Tremenheere, Esq., M.A., F.G.S.

Vice-Presidents:

Earl of Mount Edgecumbe.
J. J. Rogers, Esq.
T. R. Polwhele, Esq.
A. Lloyd Fox, Esq.

Treasurer:

William Bolitho, Jun., Esq.

Secretaries:

John Hallet Batten, Esq., F.R.G.S., M.R.A.S.
Samuel Higgs, Jun., Esq., F.A.S., F.G.S.

Librarians:

Edward Hearle Rodd, Esq.
Charles Campbell Ross, Esq.

Curators:

Clement Le Néve Foster, B.A., D.Sc., F.G.S.
J. H. Collins, Esq.

Council:

The Officers of the Society, *ex officio.*

John St. Aubyn, Esq., M.P.
Francis Boase, Esq.
E. Bolitho, Esq.
T. S. Bolitho, Esq.
J. R. Branwell, Esq.
J. Claude Daubuz, Esq.
Charles Fox, Esq.
Day P. Le Grice, Esq.
S. Higgs, Esq.
R. Pearce, Esq.
Rev. M. N. Peters.
Sir W. Williams, Bart.

PRESIDENT'S ADDRESS.

In addressing you last year I found it necessary to make a large demand upon your attention and patience. You responded to that demand with so much kindness that it shall be my endeavour on the present occasion to lay a much lighter burden upon your thoughts and your time.

Last year, I had many weighty matters to submit to you. It was a year of crisis to this Society,—to its name and fame as regards the past, and to its prospects in the future of rightly and honourably fulfilling its great objects.

Let us recall for a moment the substance of what I felt it my duty plainly to say to you on that occasion.

It was our first meeting in this noble building, and I had to recapitulate to you, with minuteness and earnestness, the facts from our *Reports* of the last thirty years nearly, shewing the objects for which this building has been designed. The great purpose kept in view by each successive Council of our Society and the whole body of its members from the earliest movement in favour of a new building was, as I exhibited to you, that we should provide adequate accommodation—not only for our "very extensive and important mineralogical collection," but beyond this, and even more particularly because more urgently required, for our large and increasing collection of fossils.

The latter branch of our collection has been assuming for many years greater and greater prominence. About the year 1845 the two new creations of geological science—fossil zoology and fossil botany,—sprang into existence. To the general surprise, these

discoveries were soon found to have a deep interest for this county. Our old rocks were found in several localities to be rich in organic remains. Our fellow-Cornishmen, Mr. Peach and Mr. Couch, poured in upon us the proofs. In 1850 a collection of Cornish fossils, made by Mr. Peach, "consisting of some thousands of specimens," was purchased and presented to us; in 1851 Mr. Giles's collection was purchased. The study of the fossil geology of Cornwall has since that time been making great and striking progress; illustrations of it have been accumulating; and space and arrangement are only required to bring to us large accessions from various labourers in the same field.

Now with these facts before me I felt, as I have already said, that last year was a year of crisis to this Society. We were all aware of the main objects for which this spacious building of ours had been designed, and yet there was imminent danger that one of those main objects,—the providing suitable accommodation for our fossils,—would rest unaccomplished. And why? We were in debt; we could not afford it; it was even considered that it might be necessary to suffer a portion of our new building to pass for a time out of our hands. And this, almost literally before the very mortar was dry with which it was constructed. I, for one, could not bear the thought of such an humiliation. Mine was only a reflex of the general feeling. It was determined that a general effort should be made to rescue us from such a position: it has been made, and it has been to a very great extent successful.

Now that we are nearly out of the scrape let us look back at it for a moment. We can do so now somewhat complacently. Let me remind you, in a few words, what it was; how we got into it; and how we have got out of it, or very nearly so.

It was just this; it is the old story; whoever has dallied with brick and mortar knows the story well. Those materials have a very bad reputation. They possess seductive qualities which it requires mature age and sad experience to be able to resist. Our Council of that time was unable to resist them. They were led on to spend, like other folks similarly situated, much

more than they had intended, much more than prudence dictated, much more than they had to spend. They had about £2,500 to spend, and they spent nearly £3,500.

We, nevertheless, have to thank them for the boldness which caused us to possess this magnificent building, while to us has remained the humble part of paying the bill,—which we have nearly done.

And how have we done it? I venture to say that the manner reflects credit on this town. In the first place, I was able to announce last year that a lady, whose munificence towards the objects of this Society appears to grow with its exercise,—impelled by an intelligent devotion to those objects, and by hereditary sympathies,—that this lady to whom we are already so much indebted had volunteered to relieve us of all permanent charge in respect of £500 of our debt on conditions which it would be perfectly easy to fulfil. Those conditions have been fulfilled, to the lady's entire satisfaction, so that we may dismiss that £500 from our minds.

With regard to the other £500, my first act was to address myself to the Mayor and Corporation of this town. To my appeal they most liberally responded with a gift of £100. In return for this liberality the town has every reason to expect, and this society is most anxious to grant, all practicable facilities to the public to see, to examine, and to profit by our collections. The extent to which this may be done is only limited by the means we have at command. The extension of those means is the great object which I have now at heart in relation to this Society, and, as long as I have any connexion with it, no effort of mine shall be wanting to expand its means of usefulness until they embrace every species of instruction which it is so capable of promoting, and until its doors are open from morning to night.

The gift of £100 by the Corporation left £400 to be raised by the inhabitants at large. This, I am happy to announce, to a great extent has been done, with scarcely any assistance from any one living more than ten miles away; and it was the more

creditable that it should have been done by the town itself, because of the depressed state in which the mining interests of the neighbourhood had long been, and by which the prosperity of this community has been much affected.

So much for the past.

Now we are on the eve, I trust, of being able to start fair upon our future career, whatever that may be. We can look around us with satisfaction,—I may say with an animating feeling of gratification; what we see around us we may now venture to call really our own; and the thought may well brace us up to the consideration of what we can best do with it.

You may remember that in my last year's address I presumed to set before the Society two principal objects to be aimed at in the application of the space at our command in our large lower room and in our spacious basement story; 1st, the fitting-up of the large room for fossils; 2nd, the fitting-up of a portion of our basement story as a first-rate laboratory, and for chemical lectures.

As regards the first subject, I took an early opportunity, after my return to London, to communicate personally with Mr. Etheridge, the gentleman in charge of the fossil department of the Museum of Practical Geology in Jermyn-street. I submitted to him the plan of the room, explained to him our wants, and asked his advice as to the mode he would suggest for meeting them. I had calculated from the plan, founding my estimate on the arrangements in Jermyn-street, that we had in wall space, in room for cases on the floor, and in drawers, a total space for fossils of 656 superficial feet.

Mr. Etheridge recommended that, without doubt, our cases on the floor should be appropriated to our Cornish fossils. That is the part of our fossil collection that visitors in general would be most anxious to see; and there they would be at once under the eye.

The wall cases on three sides of the room Mr. Etheridge found would afford ample space for very interesting and instructive collections illustrating, by typical specimens, the three great distinctive

periods and classes—namely, the Palæozoic, the Mesozoic, and the Kainozoic,—divided as he has marked on the face of the plan.

If we are to have in this building, as I trust we shall, classes for regular and serious instruction, a complete collection of this kind, clearly and scientifically arranged, as above indicated, is indispensable for the acquirement of sound geological knowledge. Mr. Etheridge most kindly informed me that, with a view to promote so desirable an object, and in furtherance of the science to which his life has been devoted, he would, if desired by us, take upon himself the no slight trouble of procuring for us in London such a series of typical specimens as would fulfil the desired purpose. The opportunities at his command would enable him to make such a collection for us at far less cost than we could ourselves. In fact, he thought he could ensure our having such a collection at a cost not exceeding £50. Now, when we reflect for a moment on the amount of trouble, time, thought, ability, and first-rate experience, so generously placed at our disposal in this offer, we cannot but feel at a loss how adequately to express to Mr. Etheridge our acknowledgments, and our sense of what we owe him for making it.

Now—to count the cost as we go—the fitting up of the room with wall cases, centre cases, and drawers, would, as I gather from what we have paid for the cases, &c., here before us, amount to about £70. This, therefore, and the collection above referred to, would amount to £120. This is the sum we must look to as indispensable to enable us properly to fulfil our main object in building at all—namely, providing accommodation for our fossils, and thus offering the means of instruction in the science which it is the purpose of this Society to promote.

So much in regard to our fossil room. Now for our laboratory. I obtained from the Science and Art Department of the Committee of Council on Education their series of papers shewing the amount of assistance afforded by that Department towards the instruction of the industrial classes in science; and I find from those papers, and from the priced catalogues furnished by the Department,—

that the cost of the apparatus, &c., for a laboratory, would be as follows:—

	£	s.	d.
Apparatus for teaching the elements of chemistry, 31 articles of a durable nature	13	9	9
Apparatus for teaching organic chemistry, 11 articles of a durable nature	16	18	6
Price as per catalogue	30	8	3
Deduct grant of 50 per cent	15	6	1½
Cost to the Society of 42 articles of a durable nature	15	4	1½
Estimated cost of the remainder of the apparatus, as specified and priced in the catalogue, being perishable articles.....	12	13	4½
Total cost to the Society of fitting-up laboratory, exclusive of chemicals	27	17	6
To this we should add a small sum for the purpose of instruction in the geological classes. namely, diagrams of extinct animals, and geological maps	4	5	0
Total cost to the Society of apparatus for classes in geology and chemistry	32	2	6

We have seen that the cost of fitting-up the fossil room and providing a suitable collection may be put at £120; to this we have to add the cost of apparatus for classes in geology and chemistry £32 2s. 6d, making together £152 2s. 6d. as the sum to be found, as a necessary preliminary to our offering our rooms and their accommodation for the purposes of scientific instruction to those of the town and neighbourhood who may desire to avail themselves of such opportunities.

But this, I regret to say, is not all. Our treasurer will have to inform us that, meritorious as have been the exertions made on all hands among us, to clear off our entire debt upon the building in the course of the past year, a sum remains, compounded

indeed in part of an excess of annual expenditure over income for a few years past, a sum remains, to set us entirely free, of £180.

We have, therefore, to look these facts in the face. Before we can turn our attention to that which, I believe I may say, we all earnestly desire,—the making our Society useful for the purpose of encouraging and diffusing instruction in science—we must contribute among us a further sum of, in round numbers, £330. The town and its immediate neighbourhood have, in the last year, come forward with a sum of £400 towards extinguishing our debt. It will not halt,—I earnestly believe,—it will not halt now that it has got more than half-way. It will, I confidently anticipate, pursue its objects to the end, and thus reap the satisfaction, not only of having inaugurated a good work, but of having secured its accomplishment.

Now I will, if you will permit me, make a forecast of time, and suppose these immediate wants provided. What will engage your attention next? Manifestly the mode of establishing such classes as we desire to set on foot.

While I was putting together the information I have just laid before you respecting the cost of fitting up the fossil room and the laboratory, and providing it with apparatus, I obtained, and read carefully through, the whole of the papers of the Science and Art Department in which they announce the conditions and the amount of the aid which they offer for the encouragement of instruction in Science. The principal paper occupies twelve pages, and being necessarily drawn up under different heads, it is not easy to gather at once its full purport. I have thought, therefore, that I might do an acceptable service to those who wished to consider the matter, if I brought together, in a new classification, the facts most important for us to know. I have, accordingly, in a short paper of five pages, enabled any one to see the bearing of the whole scheme of aid at a glance.

First I shew that aid is given in ten forms, which I describe briefly in detail. Secondly, I shew the conditions on which this liberal amount of aid is offered. The conditions are four. Thirdly,

I point out the sources from which such an income can be obtained as well secure the services of good teachers. These conditions are also four. I presume to think that it may be useful to put on record, in this address, these facts, as the time is not, I trust, far distant when such information may be required by the Council of the Society, and by others, with whom we may be enabled to co-operate.

For the encouragement of instruction in science! Can it be possible that, at this time of day, in this county, it can be necessary to say a word, by way of advocacy, upon this subject! And yet we hear on all sides that in this county the study of science languishes. What darkness is it, what wilful shutting of the eyes to the light can it be, which causes that in a county more than any other in England depending upon science for such prosperity as is left to it, instruction in science should have a hard struggle to live? What more can be said than has been said to shew its supreme importance to us? Far stronger than any reasoning, however, is the logic of facts patent to every eye. Do not they demonstrate at every turn what we owe to science, and what we may still expect, and are now driven, in the present depressed condition of the mining interest, fervently to hope from her? If we do not call her, with the utmost earnestness, to our aid, will others, do others, in foreign countries, who are our competitors, abstain from doing so? Are they not, in point of fact, rapidly redressing the balance against them, if any exists, in less natural aptitude, less experience, and greater distance, by every aid that the study of science for technical purposes can afford, coupled in many cases with mineral resources more easily got at and more easily worked? To what have the efforts of many enlightened men in Parliament, connected with the mining and manufacturing interests of the kingdom, been of late years more vigorously directed than to the endeavour to awake the public opinion of the country to the pressing necessity for diffusing technical, that is scientific, education throughout the length and breadth of the land, as the only hope now left us of holding our own against the foreigner?

To come nearer home, is it not on record, that in this very county, during the past two years, two great means and instruments of improvement have been introduced, one in each of the two main departments of mining operations? In the process of getting the ore, Dœring's boring machine, lately introduced from Saxony, and now greatly improved, had, as Captain Teague informs us, been at work in the Tincroft mine for nearly twelve months previously to September in last year, and had answered his expectations fully; doing its work, Mr. Charles Fox writes, "in one third of the time, and at half the cost, of manual labour."—*(Report of the Miners' Association for* 1868-9, *p.* 23.*)*

In the process of dressing the ore, a new method has recently been invented for separating copper and iron from silver or tin, "which has been working successfully now for some months." —*(Ibid, p.* 5.*)* And who was the inventor of this new method? Mr. R. Pearce, one of the lecturers of the Miner's Association. Well may it be said by the Rev. Saltren Rogers, in noticing this fact in the last Report of the Miners' Association, that "the residence among us of such lecturers, and the intercourse they have had with so many of all classes engaged in mining" must have tended, not only to the advancement of the application of science to our mining industry, but to the appreciation of science in the county.

Again, within the last few days, a new stamping machine has been shewn in operation by the Messrs. Harvey, of Hayle, which bears the same relation to the old stamps, which have been used unaltered, except in applying steam to them, for generations, that the Nasmyth steam hammer bears to the old tilt-hammer. It will consequently do a far greater quantity of work at a greatly reduced cost. It will be of the greatest advantage just where wanted,—namely, in reducing the ores of poor quality which, when prices are low, do not pay for working. It is obvious that the greater the number of men whom we may have in Cornwall whose minds are opened, by comprehensive scientific knowledge, to observe with a view to improvement, the old processes around them, the less the

probability that the mining interests of the county will have to wait as long for other useful amendments as they have done for these new stamps. Their value has been tested in the mines of Lake Superior. Mr. Sholl suggested them to the Messrs. Harvey, and the general opinion appears to be that the Messrs. Harvey have so constructed them, as regards lightness, efficiency, and non-liability to get out of order, that they will prove an immense boon to the county.

Although the importance of widely-diffused scientific knowledge among those engaged in the practical operations of mining is so obvious, nevertheless science, and scientific institutions, need countenance and support.

The Miners' Association, which is engaged in imparting that knowledge, is not well supported. It may be that four scientific institutions are more than the county is inclined to support. It may be that fewer would answer its needs. According to the judgment of many, I believe, fewer would be sufficient. I think I may venture to say that if this Society is to continue one of them,—this Society which dates its existence from 1814, whose *Transactions* have given it, and continue to give it, a strong title to respect, and which has shewn its vitality by so splendidly endowing itself with its new habitation,—I may ventnre to say that this Society, acting, as it is prepared to do, in conjunction with the Science and Art Committee of the Town Council, would afford a guarantee that classes for instruction in science would be efficiently conducted, under the supervision of a permanent body, in a building affording abundant accommodation; and that from this centre the highly-qualified teachers whom we should hope to secure would go forth, to give courses of similar instruction in all the neighbouring centres of mining industry.

I would just say in passing,—lest it should be thought that in urging the value of scientific instruction in this county I have in view the mining community alone,—that the agricultural and commercial interests of the county are equally included, both directly in reference to their own objects, and indirectly as being

immediately affected by what touches the mining interests. Only a few days ago one of the largest growers of vegetables and fruit in the parishes of Gulval and Ludgvan gave me this illustration of it. He supplies the Redruth market. A few years ago his largest crops did no more than meet the demand. This year he had not more than half a crop; yet it was as much as the market could take. The young men, the families, were gone, who were his former purchasers: many of the mines had ceased working, others were only partially worked; the capital was not embarked, the wages were not earned, the wealth was not created.

We are all, in fact, embarked in the same boat. No persons can see more plainly than the inhabitants of this town the interdependence of mining, commercial, and agricultural prosperity; and they are, in fact, doing their own work,—promoting in the most permanent manner their own well-being and that of their families,—when they are preparing the way for the establishment among themselves of the means of sound scientific instruction. What they have put their hands to, they will, I am confident, complete; and I look forward to seeing the day, at no distant interval, when those means of instruction which I have set before you to-day will be in action, and will be conferring benefits on all around us.

I said just now that our volumes of *Transactions* have, for many years, given to our Society, and continue to give it, a strong title to respect. I have before me the proof-sheets of a volume, now nearly completed, which, there can be no shadow of a doubt, will add enormously to that title. It is Mr. William Jory Henwood's second volume of his great work on metalliferous deposits, and on the working of mines and their results. It will form the 8th volume of our *Transactions*. It is the fruit of twelve years of unremitting labour. Mr. Henwood's 1st volume, the 5th of our *Transactions*, procured for him a very high place among the many distinguished investigators of the same subjects. The 5th volume is on the metalliferous deposits of Cornwall and Devon, with observations on their subterranean temperature, the quantities of water which enter them, and the electric currents observed in

them, together with a great mass of mining statistics. This volume will exalt the admiration, already so keenly felt, for his unwearied industry, his vast experience, and his comprehensive learning, and will kindle the gratitude of every enlightened student of the great and varied problems connected with mining throughout the world.

A bare enumeration of its principal subjects will shew the extent of the field covered by this remarkable book of not far short of 800 pages. It treats of the metalliferous deposits of North-western India; the great mining districts in Chili; the famous gold mines in Brazil; the gold productions of Australia, California, and Russia; the native copper mines of Lake Superior; the metalliferous deposits in New Brunswick and Nova Scotia; the copper mines in Ireland; the gold deposits in Wicklow and in North Wales; the Caradon and other districts in East Cornwall; and it contains descriptions of, and a mass of facts gathered from other mining districts in Bengal, in the United States, in France, Spain, Jamaica, Scotland, and this country.

Mr. Henwood informs me that by this day next year all the geological part of his work will have passed through the press.

What remains to be completed is some addition, in an appendix, to a considerable "Series of observations on subterranean temperature," a subject to which, it is well known, Mr. Henwood has devoted great attention.

In the last page of the work, which bears date the 23rd of October, 1869, Mr. Henwood states that his pages give descriptions, in greater or less detail, of more than one hundred and thirty mines, (in the various parts of the world above enumerated,) "together with comparisons of the conditions under which the various metals occur in them;" and that his chief purpose has been "to render the experience gained in one country practically useful in another." All subjects, therefore, are treated of, which Mr. Henwood found to bear "on the history, progress, and economy of mining." The numerous tables throughout the work must have been compiled, and their results worked out, at the cost of such labour as it is not easy to find an adequate epithet to

describe. Equally difficult is it adequately to characterise the vast treasure-house of references and facts constructed in the notes from the literature of almost all Europe and America. To pronounce the eulogy of this book I make no pretensions. It would be highly presumptuous in me to attempt to do so. But I have thought it my duty to lay before the Society a bare description of it, by way of showing what is in store for us. The great and noble object of both these exhaustive works has been, in the words towards the conclusion of Mr. Henwood's first volume, (p. 459) to aid "in determining those general laws, the discovery of which is always reserved as the last reward of diligent and patient research." If it is reserved to others to reap that full reward, it will never be forgotten that Mr. Henwood's vast labours cleared the way, and pointed the direction of those discoveries which, when made, will confer incalculable benefits on the human race. Of Mr. Henwood's continued abstinence from taking his part in the executive business of our Society, as a member of our Council, I cannot but speak with regret. But Mr. Henwood informs me that, were there no other reason, the prospective occupations of his time for the next two years would prevent it.

I now come to the mention of another subject which is well calculated to confer great gratification on every member of our Society, and to add in a very marked degree to its means of usefulness and, therefore, to its prestige and importance.

The lady to whom this Society is already more indebted than to any other of its members, signified to the Council of the Society last year her desire to transfer the beautiful and valuable mineral collection of her late father, Mr. Joseph Carne, to a building to be erected by her on the vacant space belonging to us, to the north of, and in connection with, this building.

The offer was one of no ordinary kind. Not only is the collection of great pecuniary value, but the Museum to receive it was to be built at Miss Elizabeth Carne's sole expense. Such a collection, in addition to our own very extensive and excellent one, would tend to greatly increase the resort to us for the purposes of study.

It would also keep in vivid memory, in a manner very acceptable to us all, the name of Mr. Joseph Carne, and hand it on to other generations as one who, during very many years of a most active and useful life, made the prosperity of this Society one of his great objects, and freely and perseveringly devoted to it, on our Council and as our President, the high talents and the accurate scientific acquirements for which he was distinguished.

In order that this most liberal and valuable proposal might be carried into effect, the Council met Miss E. Carne's wishes on every point which she considered necessary for the security and the right use of the collection, and we have embodied in our minutes all the resolutions which would give effect to those wishes.

I had hoped to be enabled to announce that a little obstacle, which unexpectedly arose, and has caused an interruption in the course of the proceedings, had been overcome. I still trust that it soon may be by that exercise of good feeling and right understanding which is seldom appealed to in vain.

I have but one other subject to call your attention to, and for only a few minutes. The original laws of the Society date from its foundation in 1814. They are very brief, and inadequate to the purposes of the Society in its present state. They were indeed slightly revised and added to in 1815-17; but it was not until 1863 that any attempt was made to adopt them to the requirements of a large Society. In that year Mr. Coulson, then residing at Kenegie, devoted much pains towards forming a suitable code of rules for us; and Mr. S. Higgs, jun., in 1866, submitted several amendments on that proposed code, to our Council. Last year I found the matter still unsettled, and I was requested by the Council to turn my attention to it. Taking the original rules of 1814, and the other revisions and proposals above adverted to, together with the rules of the Geological Society of London, as my guide, I have framed this code which I now beg leave to offer for acceptance by the Society. They have been submitted to the Committee of Papers, and carefully examined by them, and have

met with their approval. According to notice, this meeting, at its termination, will be made special, for the consideration, and I venture to hope, for the acceptance, of these rules.

THE FIFTY-SIXTH ANNUAL REPORT OF THE COUNCIL, 1869.

At the last annual meeting the Council entered very fully into the whole circumstances of the Society, and their Report, together with the address of the President, is in the hands of the members, as contained in the 55th printed Report. On the present occasion the Council are still able to congratulate the Society on the progress which is visible, in the arrangement of the mineral collections, and in the constant additions made to the Museum. It is true that a complete open exhibition of our existing treasures remains an important desideratum; but, since the foundation of the Society, there has never been so gratifying a display of its wealth as that which now meets the eye; and the Council must still continue to express their acknowledgments to those who have, by their zealous labours, contributed to this happy result.

During the spring of this year we were fortunate enough to secure, for nearly a month, the services of the Society's old friend, Mr. C. W. Peach, for the identification and re-arrangement of his own most interesting collection of Cornish Fossils; and the result of his visit to Penzance, after his own long course of scientific research in other quarters, and with reference to the general attention paid recently by eminent men to the Devonian series of rocks, will probably form an epoch in the history of geological science.

During the year under report, the influx of visitors to the Museum—some of them distinguished as geologists, mineralogists, &c.,—has been very remarkable; and among the names the Council have been glad to notice numerous pupils of the Miners' Association, brought hither under the guidance of their able lecturer, Mr. J. H. Collins.

In March last an interesting communication was received from Professor Wm. Wagner, of the Wagner Free Institute of Science, Philadelphia, United States, in consequence of which our joint honorary Secretary, Mr. S. Higgs, junior, has been preparing a collection of Cornish tin ores,—now almost ready for dispatch to the Philadelphia Museum,—in return for which we are promised a supply of rare metallic and mineral substances from America.

The reduction of the Society's debt—stated in round numbers last year at £1,000—occupied the earnest attention of the officers of the Society immediately after the annual meeting of 1868. The active canvassing for subscriptions which then followed, has been so far successful that at the present moment our whole liabilities do not amount to quite £200; which sum is partly composed of an item of £44,—a long accruing debt on the general account,—the occasion of which will not recur.

The Council propose to print and circulate a list of subscribers, but they cannot allow the present occasion to pass over without publicly acknowledging the great liberality of the Town Council of Penzance, in voting the sum of £100 as their own contribution to the relief of our finances. We trust the time is not far distant when this town and neighbourhood will reap the advantages of the Society's prosperity, in the facilities which we hope hereafter to afford for the scientific education of the young.

We may here remark that with reference to the state of our finances, the Council have appointed a sub-committee* among themselves to consider in what manner the annual expenditure may be lessened without impairing the efficient working of the Society.

The Council have now the gratifying duty of announcing that there is a fair prospect of a most valuable addition being soon made to the buildings standing on the Society's premises. Miss E. Carne having expressed her wish to erect here a suitable museum for the preservation and exhibition of her late distinguished father's (Mr. Joseph Carne) almost unrivalled collection of minerals—

* Mr. D. P. Le Grice, Mr. S. Higgs, and the Ministerial Officers of the Society.

negotiations were entered into between that lady and the Council. A "Carne Museum" committee was formed; the consent of the Public Buildings Company, Town Council of Penzance, and Board of Health, was obtained to a plan of elevation in conformity with our present erection; and the Council hope to be soon in a position to report to the members of the Society, and obtain their consent to the conditions and arrangements, under which the additional Museum will be built and established for the public benefit by our constant benefactress, Miss E. Carne.

The Committee of Papers, appointed last year, have been much indebted to our President for the trouble he has taken in the matter of the Laws and Rules proposed to be passed for the government of this Society; and the annual meeting will this day be made especial for deciding the whole question of our code.

In regard to the 8th Volume of our Transactions under preparation by Mr. Henwood, the Council are able to report that it has reached its fifth plate, thirty-first table, and seven hundred and thirty-fourth page; the descriptive part has been printed, and an Appendix on Subterranean Temperature, is in a forward state. As, besides the index, little more than twenty pages now remain for its completion, the officers of the Society expect that the volume will really be in the hands of subscribers before Midsummer next. Then it is hoped that immediate measures may be taken for publishing a ninth volume of our Transactions, for which materials are fast being accumulated.

The Council having had under their consideration the subject of the Curatorship, more especially with reference to the constantly increasing number of visitors to the Museum, think it advisable to recommend that the Curator in future shall be a resident of Penzance; and they propose that the Council, at an early meeting, shall select a suitable officer. In the meanwhile the hon. Secretaries will take charge of the current duties of the Curator's office.

In conclusion, the Council record their regret at the loss to the Society by death of the Revd. Uriah Tonkin, one of our original and most valued members, and of Dr. Thomas Barham, of Exeter,

one of our corresponding members, and a contributor to our Transactions, and well known as an author. On the other hand, four new members* have been added to our numbers, and the meeting will to-day be asked to elect others, some of whose names are well known in the county of Cornwall.

(Signed)

J. HALLET BATTEN, } *Secretaries.*
S. HIGGS, JUN., }

November 5th, 1869.

*Viscount Falmouth; Mr. W. Husband, Hayle; Mr. Lovell Squire, Jun., Falmouth; Mr. C. Puxty, Essex.

LIBRARIANS' REPORT.

THE following Books and Periodicals have been received since the last Annual Meeting.

1.—Mineral Statistics of United Kingdom.
2.—Journal of the Geological Society.
3.—Philosophical Magazine.
4.—Annals and Magazine of Natural History.
5.—Proceedings of Royal Society.
6.—Report of the Smithsonian Institution.
7.—Proceedings of American Philosophical Society.
8.—Hugh Falconer's Palæontological Memoirs.
9.—Sir C. Lyell's Principles of Geology.
10.—Annales des Mines.
11.—Report of the Devonshire Association.
12.—Reports of Mining Surveyors and Registrars, Melbourne.
13.—Transactions of Palæontological Society, Vol. XXII.
14.—Proceedings of Royal Physical Society, Edinburgh. (From the Hon. Librarian of the Society.)
15.—Proceedings of the Bristol Naturalists' Society, Vol. III.
16.—Report of the Miners' Association for Devon and Cornwall.
17.—Annual Report of Royal Cornwall Polytechnic Society.
18.—Address by Mr. W. J. Henwood to Royal Institution of Cornwall.
19.—Report of the Geologists' Association.
20.—Pamphlet on Phœnician Tin Trade of Cornwall. (Presented by Mr. Richard Edmonds).

21.—Report of British Association for Advancement of Science.
22.—True Theory of the Earth, by Research. (From the Author)
23.—Rules of the Science and Art Department of the Committee of Council of Education, South Kensington, with Abstract by Mr. H. S. Tremenheere.

E. H. RODD,
C. C. ROSS, } *Librarians.*

November 5th, 1869.

CURATOR'S REPORT.

THE Presentations to the Museum during the year 1868-9 have been numerous and interesting, as will be shewn by the following List of Donors and their Gifts.

From Mr. George Cave,—

Two Specimens of Graphite (Plumbago), from Borrodale.
A Specimen of Grey Iron Ore, from Mendip.
Ditto Petrified Wood, from Trinidad.
Ditto Mineral Pitch, from Trinidad.
Ditto Slate with Ammonites, from Pennearth Cliff, Glamorganshire.
Ditto Fibrous Gypsum, from the same locality.
Ditto Amber with Insects inside.
Ditto Oak Wood, from Submarine Forest, at Lariggan, Mount's Bay, Cornwall.
Ditto Bog Oak, from County Down, Ireland.
(N.B. Both these Specimens are polished.)

From Mr. Murphy, Penzance,—

A handsome Specimen of Barytes or Heavy Spar.
Ditto ditto Polished Fluor Spar, from Pedn-an-drea Mine, Redruth.
A beautiful Stalactite of Brown Sulphate of Barytes, from Derbyshire.

From Mr. J. Clark,—

Portion of Femur of Fossil Elephant, from Delhi, India.

From Mrs. Couch,—

Specimen of Fossil Orthis and Turbinolopsis, belonging to the Cornish series of Polruan, &c.

From Capt. George Doherty Broad, R.N.,—

Specimens of Porcelain Brick, from Nankin, China.

From Mr. John Millett, of Bosavern,—

A large Block of Tin, originally procured in 1858, from North Wheal Vor Mine.

From Mr. George Millett,—

Vegetable debris, Hazel-nuts and Wood, from Submarine Forest of Mount's Bay.

From Agents of South Wheal Crofty Mine, Camborne,—

A splendid Specimen of Carbonate of Iron and Copper Pyrites.

From Mr. George Olver,—

Specimens of China Clay Stone, from Bloomdale, St. Stephens.

From Mr. William Thomas, of Germoe,—

Quartz Crystals with irridescent Copper Ore, or Chalcopyrite.

From Lieut.-Col. Tyacke,—

Carbuncles and Garnets, from Rajpootana, India.

From Master John O'Brien Tandy,—

Cut Granite, from Quarries of Earl Annesley, Castle Wellan, Co. Down, Ireland. (N.B.—The Albert Memorial, in Hyde Park, is partly built of this granite.

From Mr. Dodge,—

Rolled Pebble of Porphyritic Greenstone, from Prae Sands.

From Mr. Thomas Cornish,—

A polished Specimen of Fine Grained Granite, from site of Small's Lighthouse, Welsh Coast.

From Mr. James Scott, Penzance,—

Specimens of Sicilian, Italian, and English Marble.

From Mr. Jonathan Couch, of Polperro,—

Portion of Stalactite, from High Cave, Gibraltar.

Conglomerate Rock, with Fossil Shells, from Australia.

From Mr. William Bolitho, Jun.,—

Garnets in Mica and Quartz, from the Simplon.

From Mr. John Martyn,—

Large assorted Specimens of China Clay, from St. Austell.

From Mr. C. W. Peach,—

A Specimen of Black Band, from Auchenbeath, Lesmahagow.

Two Specimens of Oolitic Quartz, from Sutherland.

From Mr. Drew, Penzance,—

Three Nodules of Iron Pyrites (Marcasite), from Chalkdowns and beach, Isle of Wight.

From Mr. S. Higgs, Jun.,—

Twenty-four Specimens of Magnetic Iron Pyrites, Gneiss, Mica Slate, and Primary Limestone Rocks, from Laurenberg, Sweden.

From Mr. Hallet Batten,—

Coarse Garnets from Mica Slate, in the Kumaon-Himalya.

Two Potstone Cups, from Rajpootana, India.

From Messrs. Batten and Higgs, Hon. Secs. of the Society,—

Two Logs of Wood, from the Submarine Forest, at Lariggan, Mount's Bay.

From Mr. Alfred Lloyd Fox,—

A Specimen of	Conglomerate,	from	Mount	Lebanon.
Ditto	„ Lignite	„	„	
Ditto	„ Ironstone	„	„	
Fossils including	Isocardia	„	„	
	Hippurites	„	„	
	Conus	„	„	
	Buccinum	„	„	
	Ostrea	„	„	
	Echinodermata	„	„	
	Ammonites	„	„	
	Encrinites	„	„	

Fossil Fishes, from Ghaza, near Beyrout.

Nummulitic Limestone, from Mount Lebanon.

Specimens of Kyanite, Talc and Chromite, from Shetland.

Large Stone Weapons, from the same locality.

Portion of Skull and Horns of the Irish Elk. *(Megaceros Hibernicus.)*

From Dr. C. Le Neve Foster,—

A Specimen of Scheelite, from the Val Toppa Gold Mine, Italy.

From Mr. A. P. Vivian, M.P.,—

Coal Fossils, from South Wales.

J. H. COLLINS,
Curator.

November 5th, 1869.

TREASURER'S STATEMENT.

RECEIPTS.

	£	s.	d.
To Subscription of His Royal Highness The Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears...	77	19	0
Balance due to Treasurer	44	1	4
	£142	0	4

EXPENDITURE.

	£	s.	d.
By Balance from 1867–8	48	12	5
„ Rates and Taxes	0	8	0
„ Housekeeper (18 months)	9	15	0
„ Coals	1	16	0
„ Insurance	2	12	9
„ Expenses of Secretaries and Treasurer	3	6	6
„ Advertising	3	8	2
„ Sundry Bills and Vouchers	14	1	4
„ Subscription to Palæontographical Society	1	1	0
„ Books and Printing	42	12	0
„ Expenses connected with Lecturer ...	14	7	2
	£142	0	4

November 5th, 1872. 69

WM. BOLITHO, Jun.,
Treasurer.

LIST OF PAPERS READ AT ANNUAL MEETING,

NOVEMBER 5TH, 1869.

1.—Remarks (with a list) on some of the Organic Remains in the Museum of the Royal Geological Society of Cornwall, by Mr. C. W. Peach, of Edinburgh, A.L.S., and Corresponding Member of this Society.

2.—Notes on the discovery of Organic Remains in the rocks of Nelly's Cove, near Porthalla, and of some curious Organic-like Masses in a quarry, near Hayle, by Mr. C. W. Peach, &c., &c.

3.—On the Geology of Lundy Island, with a Map, by Mr. Nicholas Whitley, &c., &c., of Truro.

4.—On Earthquake Sea Waves, by Mr. R. Edmonds, of Plymouth.

5.—On Microscopic Mineralogy and Geology, by Mr. W. Vivian, of Mwyndy, near Ponty Pridd, South Wales.

6.—On Fossils of Mount Lebanon, Syria, specimens of which have been presented to the Museum, by Mr. Alfred Lloyd Fox.

7.—On the Magnesite of Silesia, by Mr. Lovell Squire, jun., of Falmouth.

Mr. Warington Smyth, F.G.S., &c., Honorary Member of the Society, also addressed the Meeting, and offered some explanatory observations on the Gold Streams of the North of Scotland, &c. A discussion as to the existence of the precious metal in Cornwall and elsewhere followed, in which Mr. Robert Hunt, F.R.S., Dr. Barham, and Mr. T. S. Bolitho took part.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

FIFTY-SEVENTH ANNUAL REPORT,

&c., &c.

PENZANCE.

1870.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

Her Most Gracious Majesty the QUEEN.

Vice-Patron:

His Royal Highness the Prince of Wales, K.G., &c., &c.

Trustees:

Thomas S. Bolitho, Esq.
John S. Enys, Esq., F.G.S.
Day P. Le Grice, Esq., M.A.

OFFICERS AND COUNCIL FOR 1869-70.

President:

Hugh Seymour Tremenheere, Esq., M.A., F.G.S.

Vice-Presidents:

Viscount Falmouth.
Samuel Higgs, Esq.
E. Smirke, Esq.,
R. Tweedy, Esq.

Treasurer:

William Bolitho, Jun., Esq.

Secretaries:

John Hallet Batten, Esq., F.R.G.S., M.R.A.S.
Samuel Higgs, Jun., Esq., F.A.S., F.G.S.

Librarians:

Edward Hearle Rodd, Esq.
Charles Campbell Ross, Esq.

Curator:

George B. Millett, Esq.

Council:

The Officers of the Society.

John St. Aubyn, Esq., M.P.
Francis Boase, Esq.
E. Bolitho, Esq.
T. S. Bolitho, Esq.
J. R. Branwell, Esq.
J. Claude Daubuz, Esq.
Charles Fox, Esq.
Day P. Le Grice, Esq.
N. B. Downing, Esq.
T. R. Polwhele, Esq.
A. Lloyd Fox, Esq.
Major J. S. Bickford.

PRESIDENT'S ADDRESS.

On surveying the large number of persons now before me, in this spacious room, I cannot refrain from congratulating the Society on such an attendance on the present occasion. I am glad to perceive among them so large a proportion of our more prominent members, distinguished either as men of science, or in other spheres and vocations. Some, I know, have attended to-day at great personal inconvenience; some have, most kindly, come from long distances; all impelled with the desire of shewing their interest in, and doing honour to, the Society. Among those now present, I am greatly gratified by being able, on behalf of the Society, to welcome again among us a very eminent member of our body, Mr. Henwood, President of the Royal Institution of Cornwall, of whose recent labours I shall soon have occasion to speak, who has always been ready and willing to aid us by his counsel, and from the ample stores of his information; and whose presence here to-day may be taken as a mark not only of his own good-will towards this Society, but of the friendly feeling towards us of the Institution over which he presides. Among those also who have favoured us with their attendance to-day I cannot fail to advert with gratification to the ladies, and to those especially who for many years have shewn so much zeal and intelligence in promoting the interests of the Society.

The subjects which I have to lay before you to-day are few, but you will not, I believe, think them unworthy of engaging your attention. They are few, inasmuch as the past year has been to this Society, for the most part, an uneventful one.

In order to make clear to you the full force of that expression it is necessary for me to recall to your recollection some of the most

prominent topics of my addresses of the two last years. The main objects of my address of 1868 were to impress upon you two points: 1st, The reasons why, in this town and neighbourhood, geology, mineralogy, and chemistry should be effectively cultivated; 2ndly, The fact that in this noble building we have the necessary conditions for such cultivation, namely, our valuable collections of mineralogy and geology, and ample space to display them; also abundant accommodation for a laboratory and class-rooms. The principal question then, as now, before us was how to make those means available. This was governed, obviously, by the state of our funds, and I had, in 1868, to shew a serious deficiency. In my address, however, of 1869, I had the satisfaction of describing the great effort that had been made in the interval. I was able to announce that, by the munificence of some of our friends, and by our general exertions, out of a total expenditure upon this building of about £3,500 we had reduced our liabilities to under £200. At the same time I pointed out that if we wished to attain our ultimate object,—that of making this Society a centre of sound scientific instruction in the branches above-mentioned, for the town and neighbourhood,—funds must be raised for the following purposes: 1st, We ought to obtain a typical collection of fossils; and I acquainted the Society of the obliging offer of Mr. Etheridge, the gentleman at the head of the fossil department of the Museum of Practical Geology in Jermyn-street, to give us his valuable services in obtaining for us such a collection, which he thought he could do for the sum of £50. 2ndly, We must, at a cost of about £100, fit up our lower room for the reception of such collection, together with our own collection of Cornish fossils, which Mr. C. W. Peach has pronounced very complete and interesting. 3rdly, We must provide apparatus and fittings for our laboratory and class-rooms, at a cost of about £50. Therefore, in addition to the £200 necessary to clear off our debt upon this building, we must raise £200 more if we intend to give effect to the plans which I have had the honour to submit for the consideration of the Society, by which, with the promised cordial co-operation of the Worshipful the Mayor and

the town, and with the aid obtainable from the Science and Art Department, South Kensington, we should be able to give our institution a character of general usefulness both to the town and county. In consultation with the Council of the Society I came, with them, to the conclusion that it was inexpedient to make any effort towards those purposes during the past year. Considering the great and combined exertions that had been so recently made, and with such success, we thought that a breathing-time, as it were, was necessary before we resorted to a further appeal, and that it should be deferred until next year. Things, therefore, have remained pretty much as we left them this time last year, as far as our future plans are concerned, and I have thus explained my meaning when I designated the past year as an uneventful one.

In the mean time, however, a circumstance has occurred, which I was enabled to foreshadow in my last year's address,—a circumstance affording us much encouragement and materially brightening our financial prospects. Mr. William Jory Henwood's elaborate work, which will form the 8th volume of our "Transactions," is completed and now lies before me; completed, at least, with the exception of a small portion of the index, accidentally delayed in the hands of the printer; but there is every probability that the work will be ready to go into the hands of the Society and the public before Christmas. It will form the second portion of Mr. Henwood's great and well-known labours. His first volume was the 5th of our "Transactions," and was published in 1843. Its subjects were the metalliferous deposits of Cornwall and Devon; observations on subterranean temperature in the mines of Devon and Cornwall; electric currents in rocks and veins; with notices of the amount of water in Cornish mines; and much valuable statistical information. It has, as we all know procured for Mr. Henwood a high name as a scientific inquirer. This, his second volume, is on metalliferous deposits, and on the working of mines and their results, with an appendix on subterranean temperature. It is the result of 12 years of unremitting labour. In my last year's address I called attention to the immense scope of inquiry

which it embraces, extending from the narrow range of his first volume to the mineral districts of almost the entire globe; treating, as it does, of metalliferous deposits in North Western India, in Chili, Brazil, British North America, the United States, France, Spain, as well of those in our own country.

I shall invite your attention presently more particularly to the appendix on subterranean temperatures, as a matter of peculiar interest in this county; but, for the moment, I wish you to look at the volume with me in regard to its probable financial results to the Society.

According to the agreement long since entered into by the Society and Mr. Henwood with the printer, 400 copies were to be printed; of these the Society will possess 200, Mr. Henwood 100, and the printer 100. Of the Society's 200 copies, a few must be sent to the Societies with which we interchange "Transactions." The remainder will be for sale to the members of the Society and to the public.

Your Council has recently had before it a statement of the cost of the volume to the Society, which will, for convenience sake, be bound in two parts. The cost to the Society of the volume so bound will be £1 5s. At this price it is now offered to members, and our treasurer has prepared a book in which any member now, or hereafter, wishing to have a copy or copies, may cause his name to be entered.

As regards the number of copies which may not be required by members, we have opened a correspondence with one of the principal London publishers, and there appears reason to anticipate that the negociation may end in his taking all the copies we can spare off our hands at a certain price. The price to the public will, of course, be above that to members. We are disposed to hope that our 200 copies may, before this time next year, have supplied us with the means of nearly, if not entirely, extinguishing our debt. It will then be for the Society, and the public both of this town and of the county, to consider whether they will proceed to furnish us with the remaining £200 or thereabout, which I have shewn to

be required if we are to make the great opportunities possessed by this Society available for the purposes of sound scientific instruction in the manner proposed.

I said just now that I should venture to refer more particularly to the substance of Mr. Henwood's appendices (Nos. 1 and 2,) containing his observation on subterranean temperature.

The subject has long been regarded with great interest in this county, on account of its bearing on deep mining operations. In order to a correct appreciation of the value of Mr. Henwood's contribution in this volume to the knowledge of the subject, a short retrospect of its history is necessary.

During upwards of thirty years past it has been largely illustrated in our "Transactions" by the enquiries of Mr. R. W. Fox. Dr. Barham, Sir John Forbes, Mr. Moyle, and of Mr. Henwood himself, in the course of long and careful observations in this county. Of what has been done in France and Belgium, by very distinguished inquirers, as also in our deepest coal-shaft in Cheshire, a most interesting summary was given by Mr. Warington W. Smyth in his address as President of the Geological Society, in which he added the result of some of his own observations in this county, as well as a resumé of the inquiries of Mr. Fox and Mr. Henwood. To the facts thus brought under review by Mr. Smyth, in the localities above-mentioned, Mr. Henwood has added a large series of others, collected in very opposite and distant parts of the world—in Chili, Brazil, the United States, the Channel Islands, Ireland, Shropshire, and some further observations in Cornwall. An additional interest attaches to those made in Chili and Brazil—first from their having been in the Tropics; next from their having been made in localities several thousand feet above the Pacific—in Chili at an elevation of 3,650 feet; and in four places in Brazil at elevations of 3,250, 3,300, 3,360, and 3,400 feet respectively.

Among the main facts brought out by all these inquiries has been this, that an increase of temperature with increasing depth is every where recognised. But great uncertainty exists about the rate at

which the temperature advances in descending. The doubtful points are whether there is a regular scale of progression increasing directly with the depth; or whether it is intermittent, or varying with the depth; and to what extent it is effected by the different classes of rocks and different mineral deposits. Very interesting summaries are given by Mr. Henwood (p. 751,) of mean depths, temperatures, and ratios in which the temperatures increase with the depths; and of the mean depths, temperatures, and rates at which the temperatures increase with the depths of the mines which yield different metals and ores. The results under other combinations of metals, ores, and rocks (pp. 757-9,) in the mountainous ranges of the tropics, and in the less elevated parts of temperate regions,—shewing great variation in the ratios in which the temperatures increase with the depths,—are, I venture to say, of great interest. Mr. Henwood draws attention to an apparent anomaly sometimes found in subterranean temperatures, as to which he invites further inquiry.

Here and there it is found that "portions of various rocks and vein-stones are cooler than those above them." Mr. Henwood suggests that observations should be directed to the extent to which the shafts and galleries of mines disturb the ordinary course of transmission of heat towards the surface of the earth due to "the composition and structure peculiar to different strata," and to "the conducting power proper, in various degrees, to all rocks." (p. 763.)

The appendix No. 2 illustrates, by numerous and elaborate tables, the proportion of solar heat absorbed by the ground. The spot on which these observations were carried on was at Agoa Quente, (some 3600 feet above the sea) in Brazil, at depths of 3, 6, and 9 feet from the surface. All these extensive observations by Mr. Henwood, in so many different regions, and dealing with so many different conditions, verified by tables bearing testimony to the most astonishing labour, afford admirable examples of the mode of inquiry necessary towards determining the mean temperatures and ratios in any one vertical line,—a problem to the solution of which the

abilities of some of our most distinguished members has been long since directed.

Mr. Henwood's results have been obtained—1, by placing thermometers in holes in absolutely dry situations; 2, by placing them in streams of water immediately on their issuing from the various rocks and veins; every care being taken to secure the accuracy that might be expected from so experienced an inquirer.

There can be no doubt that this volume will add largely to Mr. Henwood's already high reputation, and shed additional lustre on our "Transactions.

My justification for having thus attempted, however imperfectly, to give some idea of its contents is that I might make known to those who study the questions treated of in this great work, what a storehouse of information it contains, of the greatest importance to all engaged in directing mining operations throughout the world, as well as to those who take an interest in some of the most obstruse problems which those employments involve.

The next subject which I have to bring before you is a brief reference to the fact, adverted to last year, of the discovery made by Mr. C. W. Peach, A.L.S., among our Cornish fossils, of one specimen from Porthalla Cove containing organisms, which had been overlooked during the whole time the specimen had been lying on our shelves (nearly 40 years,) and which led to the suggestion that the fact of the occurrence of organic remains at that spot should be verified.

I think it desirable to put on record, on this occasion, what has occurred on this subject.

In May, 1869, Mr. Peach very kindly assisted the officers of our Society in examining the interesting series of the rock-specimens of Cornwall made by Dr. Boase, many years ago, to see whether any of them contained organisms. Of this examination Mr. Peach gave a short notice at the meeting of the British Association in the following July, which is printed among their Miscellaneous Communications (p. 99.) The specimen in question, (No. 733) a dark limestone, attracted his attention. The curator caused it to be

rubbed down and polished, and what were pronounced to be encrinites and a coral were well shewn. Mr. Peach resolved to visit the spot and try to find the rock in situ. This, it appears, he failed to do; but, in "Nelly's Cove," a short distant to the north of Porthalla Cove, and in the direction of the mouth of the Helford Estuary, Mr. Peach discovered, in a dark slaty rock, specimens of blackened remains, being a portion of an orthoceras, similar to those found by Mr. Peach at Fowey, Polruan, &c., and deposited by him in our Museum.

It thus appears that the limestone was not hit upon by Mr. Peach; and, as much of the interest of this discovery is connected with the question of the possible indentification of the limestone in situ at Porthalla with that of the Plymouth beds, a further search among the exposed rocks in Porthalla Cove is manifestly desirable. Canon Rogers had, as far back as 1822 (vol. 2 of our "Transactions," p. 417,) discovered large blocks of drifted limestone near the same Cove. I have made application during the past year to several gentlemen highly competent to determine this question for us, but have not succeeded in inducing any one to go to the spot and investigate it. But as it is not improbable that some one will before long do so, I avail myself of the information given me by Mr. Henwood, who was present with Dr. Boase when that specimen was found, in 1830 or 1831, to indicate the exact spot from whence it was taken.

Mr. Henwood states that it was a few hundred yards in from the Cove, a little way to the right of the road, where a small rocky projection bounds the field.

A subject has been lately revived in London, which may very probably touch closely the interests of this county. This consideration justifies me in recalling to your recollection what is somewhat of an old story as regards this Society, but which has been re-invested with a present interest.

In the 6th volume of our "Transactions," published in 1846, (p. 68) is a paper by Sir Charles Lemon, Bart., our then president, containing some introductory remarks by him upon, and several

extracts from, a paper by my brother, Major-General George Borlase Tremenheere, written by him when a captain (Bengal Engineers,) and executive engineer of the Tenasserim Provinces. My brother was at that time (in 1841,) called upon by the Bengal Government to examine, and report upon, the mineral resources of Tennasserim. He visited all the tin localities then known, and some which had not been brought to notice before. His report, on being presented to the Lieut.-Governor of Bengal, was, by his order, printed in the "Journal" of the Asiatic Society of Bengal, (vol. 10, of 1841, and vol. 11, of 1842, parts 1 and 2.) This report came into the hands of Sir Charles Lemon, and was thus brought to the notice of this Society.

It is a "Report on the Tin of the Province of Mergui, in Tenasserim, in the northern part of the Malay Peninsula." The Tenasserim Provinces (Martaban and Tenasserim) are parts of the Burmese territory, which was ceded to us in 1826. The Burmese had, in past times, taken it from Siam. While in possession of the Siamese the country had for ages been worked for gold, silver, and tin. Mount Ophir, from which gold found its way to Jerusalem, in the days of Solomon, is in the southern part of that peninsula.

There are records that tin was worked in the year 1687. The Burmese neglected it, but the Siamese had carried on extensive works, the evidences of which still remain, in pits 8 to 12 feet deep in the beds, or on the banks, of streams, traceable for many miles along the line of several tributaries to the Great Tenasserim river, which passes into the Bay of Bengal at Mergui. My brother examined four of these tin grounds, all very accessible and at short distances (the furthest two days' march) from the banks of navigable rivers.

At one spot a native, under his direction, collected 11,889 grains of tin-ore in the course of an hour and a half. My brother states that the process by which it has been deposited for long periods, and for many miles along the line of the valleys through which these streams flow from the primitive mountains in the

immediate neighbourhood, appears to be in active operation at the present day.

Besides the stream-tin, he found a rich vein of tin in the side of an insolated hill about eleven miles from the town of Mergui, consisting almost entirely of decomposed granite. The crystals of pure peroxide of tin were there in great abundance, imbedded in pure kaolin. The vein is three feet wide, and was reached about five feet from the surface: it is about a quarter of a mile from the creek communicating with the river, and accessible for boats. My brother states that "In about a quarter of an hour a few baskets full of the decomposed granite were removed down the hill, and washed, and yielded 63 oz. of pure tin." My brother sent home to the India House 12 cwt. 38 lbs. of this ore and the stream tin from the other localities. It was deposited in the Museum of the India House, and a considerable quantity of it is there still. Some specimens are in the Museum in Jermyn-street; these have been recently analysed, at his request, and have been found to contain from 55·18 to 72·95 per cent of tin oxide.

In another locality in the Province, on the Pakchan river, near the southern boundary of the Province, about a couple of days' steaming south of Mergui, some Chinese, as my brother informs me, have for some years past been raising tin successfully, their produce being sent either to the Straits or to Moulmein in junks.

It is understood that their "sett" expires in about two years; and it is, I believe, this circumstance which has brought the question of the Tenasserim tin-grounds to the notice of some scientific persons, and of others engaged in commerce, in London, and revived the recollection of my brother's report.

Mergui is a town of upwards of 12,000 inhabitants; its climate is described as "excellent" and as agreeing well with Europeans; its roadstead is protected by a fine island not a mile from the coast. Labour and supplies are abundant. Its situation would, in case of its becoming a place of export for tin, gave it a great advantage over the Straits. It is in 12 degrees N. latitude. Singapore is in latitude 2 degrees North, and the islands of Banca and Billiton, the

principal sources of the Straits tin, are in lat. 5 degrees to 8 degrees South.

Being in possession of the facts I have just submitted to you, I have felt that they bore directly, and with no little force, on the question which this Society has now most prominently before it. Our main object now is to promote branches of scientific instruction in which this county is most concerned. The aid of science is now more than ever required to enable our mines to bear up against the competition which is everywhere on the increase against them. Many of us remember the apprehensions excited in the county when it first was seen to be probable that large quantities of copper would reach this country from the other side of the Atlantic. We all know the results to this county of the vast importations that have long since been regularly flowing in from that part of the world. It is from the eastern seas, and principally from the Dutch settlements that tin has yearly to look, with somewhat anxious anticipations, for its competitor. There seems to be no reason why, from our own provinces, that competition should not before long be greatly increased. There appear to be all the elements of a large production, with security for capital, cheap labour, and easy communications, to call it forth. Surely these considerations afford additional reasons why every aid that the cultivation of science can afford, should be sought for, through a more general diffusion of exact scientific knowledge, to cheapen the cost of production, and to enable the mines of this county to keep their place against the world.

The discovery of diamonds at the Cape of Good Hope, referred to in a communication by Professor T. Tennant, F.G.S., to the British Association last year, is becoming a matter of general interest. They are found, as is usually the case, in alluvial deposits. The instances in which they have anywhere been discovered in situ are, I believe, very rare. Our "Transactions" contain a mention of one of those instances, which it may be useful under present circumstances to recall attention to. The discovery was made by a Cornishman, Mr. Thomas Redington, a native of

Breage, in this neighbourhood, in Brazil, in the year 1855. An account of it was transmitted to us by Mr. Thomas Treloar, of Morro Velho, an associate member of our Society, and was published in our 43rd annual report (1856) p. 299. Not far from one of the principal rivers of the diamond district in the province of Minas Geraes, Mr. Redington found a vein or bed of rock yielding diamonds. The general rock formation of the neighbourhood is sandstone, consisting chiefly of quartz and talc, overlaid by slate. The formation, whether a bed or a vein, is interposed between the sandstone and the slate; it is described as of a soft consistency, and composed of clay, sand, and what appeared to be iron-ore. Its thickness was three fathoms, at a depth of seven fathoms from the surface, and it was at that depth the diamonds were found.

If these remarks should come under the eye of any Cornishman at the diamond-diggings of the Cape, they may, we hope, lead him to favour us with any observations that may strike him as of interest in a geological point of view.

There is one absent Cornishman whom we miss from among us this year, who has already manifested his desire to continue his aid to the Society from the very distant sphere to which he has been transferred,—Mr. Samuel Higgs, jun., who was for nearly thirteen years our secretary, or joint-secretary, and always zealous on behalf of the interests of our Society. The accounts which have lately reached us of his receiving His Excellency the Governor of South Australia at the important copper mines of Wallaroo, on Yorke's Peninsula, of which he is superintendent, shew that Mr. Higgs is as respected there as he was among us; and I have no doubt we shall hear from him on any subject of geological or mineralogical interest that comes in his way.

I have now to mention that, with a view to the, I trust, not distant prospect of our being able to complete our Museum with a good and comprehensive collection of fossils, I had the honour, on behalf of the Society, in March last, to make an application to Sir Roderick I. Murchison, Bart, K.C.B., &c., &c., as head of the Geological Survey, for a collection of fossils from the surplus stores

of the Museum in Jermyn-street, when their next distribution among scientific societies took place. Sir Roderick Murchison informed me very kindly, in answer, that, while not considering their surplus stores to be likely to be of any great value to us, he would cause the name of our Society to be so inserted on the list of public bodies desirous of obtaining specimens from them as to ensure our having "one of the best of the lots, when the period arrives."

While referring to our Museum I cannot refrain from expressing the regret, shared in, I am sure, by our whole Society, that the prospect which, at one time last year, seemed so near of our receiving the great accession of the Carne Museum, was not realised. With every desire on all sides to come to a satisfactory arrangement, the one proposed was found to be beyond the powers of the Society to accede to, and the question has been closed.

I must now proceed to notice some of the losses by death which the Society has met with during the past year.

It is a salutary practice of this and other similar Societies to put on record, in their "Transactions," brief biographical accounts of the most distinguished of their members as they drop off from them.

On this occasion the practice is the more appropriate on account of our having lost two members of particular note in their respective spheres.

Sir William Williams, Bart., has many claims to our grateful remembrance. He was for more than 50 years a member of our Society, and was on all occasions zealous and liberal in promoting its interests. The facts and notices which, from time to time, he communicated to the authors of memoirs in our "Transactions" proceeded from one who, alone of the surviving members of a generation to whom the county was greatly indebted, was able to impart it. They are printed in our 8th volume. They consist of several very interesting notices of the occurrence of silver in Wheal Basset, Treskerby, and North Downs; also of accounts of the profits made in a great number of the richest copper mines in Cornwall, wherein Sir William and his ancestors were shareholders. The chief incidents of his public career will long be impressed on the

memory of this county. Public spirit was in him the heritage of a great example. To his great-grandfather the county was indebted for the work, grand in conception, arduous and costly in execution, of The Great Adit, as it is popularly called, which, from the low sea-level of Falmouth harbour, penetrates upwards to the very centre of the mineral district around Redruth. The Mr. Williams of that day, in 1748, and for several successive years, spent large sums in making practicable the working of the mines in that district by materially facilitating the removal of the water. The Sir William Williams of our day spent, in conjunction with other members of his family, even larger sums in keeping in employ the great body of those miners at times when the prospects of the mines were gloomy, when the returns were unremunerative, and when it required no ordinary amount of self-sacrifice, of great risk, and consequent anxiety, of kindly and benevolent feeling towards the workpeople, to enable them to continue to support themselves in independence.

We have lost also, in the past year, Mr. Jonathan Couch, F.L.C., the eminent naturalist, and perhaps the greatest British ichthyologist of the day, to whom our "Transactions" are indebted for valuable papers on the cause of the red colour in the fossiliferous rocks in the neighbourhood of Looe (vol. 6, pp. 139—142;) on a supposed new species of the fossil genus Astræa, found in Cornwall, (vol. 7, pp. 244-5;) and a description of the fossils found in a quarry near Trelawny in the parish of Pelynt, (vol. 7, pp. 249—262.) Mr. Couch was a credit to the county and to our Society, and all who knew him lament his loss. His great abilities enabled him to combine attention to scientific studies, by which the public benefited, with the calls of his professional life, and he thus was one of those who illustrated the dictum that of the powers and opportunities entrusted to us "partem patria vindicat, partem amici."

The other losses which we have to regret during the past year are those of Major Bickford, of Tuckingmill, a gentleman of marked celebrity in the county, and a member of our Council; and of Mr. Richard Harvey, of Greenway, Dartmouth, and of Mr. Louis

Vigurs, of Rosehill, in this neighbourhood, for many years supporters of our Society.

Our accession of new members has been very encouraging, and I hope that the state of our funds, at the next annual meeting, may justify the Society in taking steps to realise the objects of usefulness which we have in view.

THE FIFTY-SEVENTH ANNUAL REPORT OF THE COUNCIL, 1870.

THE Council congratulate the Society on the occasion of its Fifty-seventh Anniversary Meeting, but have not much to report, their recent reports having been so full.

The Laws and Rules which were sanctioned and passed by the last year's meeting, (made at its close, according to notice, special for the purpose), have been printed, and circulated to all the members. Thus, a long existing desideratum has been supplied, and new members will henceforth possess, and be acquainted with, the code of the Society which they join.

The thanks of the Society have already been given to the President for his labours in this matter.

According to Rule XX of the Code, an Ordinary Quarterly Meeting of the Council, on the first Tuesday of November, February, May, and August, should be held. On the first Meeting in February last, held under this law, Rules of Practice as to the necessary notices and the transaction of business were prepared and circulated to the Members of Council, and have been subsequently acted upon, as far as possible.

During the year under report, that part of the Museum which is exposed to view in the glass cases on the floor of this room, has been most carefully re-examined and placed in order, according to the system commenced by our late Curator, Dr. C. Le Neve Foster; and at the present moment the labelling of the specimens of Earthy and Metallic Minerals, according to a ternary coloured division into Cornish, British, and Foreign,—has been almost entirely completed. The Council have again to repeat their thanks to the

ladies who have helped in this good work, and who have rendered light the labours of the new Curator, Mr. George Bown Millett, the gentleman whom the Council appointed early in the year, according to the power given them by the Meeting of the 5th November, 1869; and who, when not employed in the Museum, will always be ready to assist the Secretary and the Librarian in their respective departments.

Although too many valuable and instructive portions of our collection still remain ordinarily hidden from view in our drawers, nevertheless, the Museum has continued more and more to attract the visits of the public,—as proved by the long list of names in the Visitor's Book,—and more than one practically useful view of the minerals has been afforded to mining pupils and others.

While on the subject of the Museum, the Council cannot omit to thank the Society's Honorary Member, Mr. Warington W. Smyth, for his many valuable suggestions and corrections in aid of the Curator's department.

At the request of the Society's old and useful friend, Mr. C. W. Peach, a duplicate set of some of his most characteristic Cornish fossils was despatched, in 1869, to Mr. E. Ray Lankester, the eminent investigator and expounder of the Devonian fishes, &c. On our Secretary requesting that gentleman to report any results of the loan made to him, he states in a recent letter that, "though "there is a great deal that is very interesting, at the same time, "the fragmentary nature of the Remains renders attempts at "making them out very difficult, but (he adds) I am quite sure "that you may consider you have a valuable possession in these "specimens, if only as representing so much time and labour from "an acute observer like Mr. Peach."

The Council regret to inform the Society that their hopes of increasing the attraction and usefulness of their buildings by the possession of an additional Private Museum of well-known value, have been disappointed.

The solicited present of Cornish ores for the Museum of the Wagner Free Institute of Science, at Philadelphia, U.S.,—which

the Council alluded to in their last Report, has been despatched to America, consisting chiefly of Tin, but also of Copper, together with the containing rocks, and the smelted metal. Professor Wagner in acknowledging the safe arrival of the boxes, which he had not then had time to open and examine, promised in his letter to our Secretary, dated July 4th last, to help this Society in regard to a large list of Mineralogical Desiderata which had been sent to him, and more especially mentioned Gold and Silver ores from the new and great mines of Colorado and Nevada; the carbonate and red Oxide of Zinc peculiar to North America; fine pieces of Chatoyant Anthracite, Cryolite, Deweylite, Jeffersonite, Titanium, Chromium, &c., &c., as likely to form a return present to this Society.

The Council are at length enabled to announce the completion of the 8th Volume of the Society's Transactions. Save for delay on the part of the printer, the whole bound work would have been now on the table; before Christmas, however, it will be in the hands of the Members and Subscribers. Its bulk necessitates its appearance in two parts; the first consisting wholly of Geological and Mining details; the second of Observations on Subterranean Temperature, of tables, plates, and the index. As it is the object of the Society to give so many particulars, bearing on the principal industry of Cornwall, the widest circulation possible, it has been determined to forego any very large prospect of profit on the publication; the price of the work to Members and Subscribers will, therefore, be about £1 5s., and to the public somewhat more.

The Meeting will doubtless heartily congratulate Mr. Henwood on the successful termination of his arduous labours on the Society's behalf.

The Treasurer will submit his report to the Meeting, elucidatory of the state of the Society's Finances, which, though still exhibiting some debt, may on the whole be considered satisfactory, when compared with very recent returns. The Council, however, think it right to report more particularly that at their Meeting of Tuesday, May 3rd, 1870,—after examining the Treasurer's accounts,—they

thought it right and expedient to authorize that officer to overdraw the Society's Account at the Mount's Bay Bank to the extent of £120 5s. 2d., for the payment of the balance of Mr. John Matthews' building account, with interest; also for the payment of a small sum due to Mr. Freeman.* The Council request the sanction of the Meeting to this proceeding. A further small sum is still due to Mr. J. Matthews, for the liquidation of which the Council recommend a similar arrangement.

The Council have lost during the year the valuable services of their late Joint-Secretary, Mr. Samuel Higgs, jun., who resigned his office after an official connection with the Society of some twelve years, on his appointment to a situation of high trust in South Australia.

The Meeting will be glad to hear that good accounts of Mr. Higgs have been received from the Wullaroo Mines, where already he has achieved a notable position, and will doubtless join the Council in wishing him and his family health and happiness at their new home, and a prosperous return to their native land.

Death has deprived the Society of some old friends,—and the Council have now to add to their mournful Obituary Lists the names of Jonathan Couch, Sir William Williams, J. S. Bickford, Richard Harvey, and Louis Vigurs.

On the other hand, the Meeting will soon be asked to elect as Ordinary Members a few whose names† will be familiar to the County; but the Council cannot conclude their Report without

	£	s.	d.
*Balance due to Mr. J. Matthews, as certified by Auditors . .	82	13	5
Interest on £550 for 9 months, at 4 per cent. interest, as allowed to Mr. J. Matthews at last Annual Meeting	16	10	0
	£99	3	5
Balance due on Curb, &c., to Mr. Freeman	21	1	9
	£120	5	2

† Mr. J. H. Peter, Chiverton, Truro; Mrs. Richard Harvey, Greenaway, Dartmouth; Mr. Henry Grylls, Moreton House, Redruth; Mr. S. T. G. Downing, Redruth; Sir Edward St. Aubyn, Bart., St. Michael's Mount.

recommending to the Meeting that it should at once elect as an Honorary Member another distinguished brother, of an honourable Cornish family, in the person of Major-Gen. Charles Tremenheere, R.E., C.B., Bombay Army.

(Signed)

J. HALLET BATTEN,

Secretary.

October 21st, 1870.

LIBRARIANS' REPORT.

THE following Books and Periodicals have been received since the last Annual Meeting, (held 5th November, 1869.)

1.—Annals and Magazine of Natural History. (No. 23).
2.—Quarterly Journals of the Geological Society, for 1869-70.
3.—List of Members of ditto,
4.—Annual Report of the Leed's Philosophical and Literary Society.
5.—Reports of the Mining Surveyors and Registrars; and Mineral Statistics, of Victoria, for 1868 and 1869.
6.—Transactions of the Penzance Natural History and Antiquarian Society, Vols. 1 and 2.
7.—Annual Reports of ditto, from 1862 to 1865.
8.—London, Edinburgh and Dublin Philosophical Magazine, 1869-70.
9.—Report of Annual Meeting of Miners' Association, at Truro, 1869.
10.—Proceedings of the Royal Society, for 1869-70.
11.—Transactions of the Palæontographical Society, Vol. XXIII. with Appendices.
12.—From the Geologists' Association:—
Pamphlet on the Chief Groups of Cephalopoda.
Reports of the Excursions.
List of Members.
13.—From L'Universeté Royale de Norvége à Christiana:—
Le Glacier de Boium, en Juillet, 1868.
Magazine of Geology.
14.—"Microscopic Objects." By John H. Martin.

15.—"The Millstone Grit." By Major Austin. Presented by the Author.

16.—Report of Geological and Polytechnic Society, West Riding of Yorkshire, 1869.

17.—Fifteen Numbers of the Anthropological Review, and Catalogue of Library of the Anthropological Society of London, 1867, presented by Mr. S. Higgs, jun.

18.—Report of the British Association for the Advancement of Science, held at Exeter, 1869.

19.—Records of Geological Survey of India, and Palæontologia Indica, from Dr. Thomas Oldham, Superintendent of the Geological Survey of India.

20.—Annales des Mines, tome 16. From Ecole des Mines, Paris.

21.—First Annual Report of the American Museum of Natural History, January, 1870.

22.—Address delivered at the Spring Meeting of the Royal Institution of Cornwall. By W. J. Henwood, President. From the Author.

23.—A Classified Index to the Proceedings, Transactions, and Journal of the Geological Society of London. By G. W. Ormerod, M.A., F.G.S. Presented by Mr. W. J. Henwood.

24.—Report on Gold Mining and its prospects in Nova Scotia, &c. By Henry Youle Head, M.A. Presented by Professor J. Tennant.

25.—H. W. Schmidt's Catalogue des Antiquarischen Bücheslagers, 1869.

26.—Emile Bertrand's Comptoire Mineralogique, Geologique et Paléontographique.

27.—Annual Report of the Smithsonian Institute, Washington, U.S., for 1868.

28.—Smithsonian Miscellaneous Collections, Vols. 8 and 9, 1869, and Contributions to Knowledge, Vol XVI, 1870.

29.—Proceedings of American Philosophical Society, Philadelphia, 1869.

30.—Annual Report of the Department of Agriculture, Washington, U.S., 1868.

31.—A Native Map of the Great City of Osāca, in Japan. Presented by Captain George Broad, R.N.

32.—Proceedings of the Bristol Naturalists' Society, 1869.

We have also to announce that the late Sir James South gave and bequeathed to this Society his Presentation Copy of "Sir Humphrey Davy's Treatise on his Safety Lamp," and we expect soon to receive it from the Executors.

E. H. RODD, } *Librarians.*
C. C. ROSS, }

October 21st, 1870.

CURATOR'S REPORT.

THE following Presentations have been made to the Museum of this Society since the last Annual Meeting.

By Mr. Richard Bennetts, of Pendeen,—

Five Specimens of Cornish Opal, from Old Huel Carne Mine, south of Pendeen.

Specimen of Hornblende, from Pendeen, St. Just.

By Mr. J. Hallet Batten,—

Flints, with Sandstone Fragments, from Tresco Downs, Scilly.

By Miss E. T. Carne,—

Two small Specimens of Diamonds, cut and uncut.

Specimen of Quartz, Coloured by Oxide of Iron, from Huel Cock, St. Just.

By Mr. Pascoe, Penzance,—

Specimens of English and Foreign Marbles.

By Mr. S Higgs, jun.,—

Specimen of Sulphate of Baryta.

Two Specimens of Native Copper, from Lake Superior.

Flints found between the Land's End and Cairn Kenidjick.

Specimen shewing junction of Granite and Killas.

A doubtful Specimen, (having the appearance of Flint,) taken out of Granite, in the 40-fathom level at Balleswidden Mine.

By the Rev. William Rogers, Rector of Mawnan,—

Two Specimens of Carbonate of Lime, from a spot between the Nare Point and Porthalla, St. Kevern.

By Mr. T. H. Davies, Scilly,—

Specimen of Paraffin Slate, from Mount Victoria, Australia.

By Mr. S. Higgs,—

Specimen of Purple Copper Ore, from Trelyon Consols Mine, near St. Ives.

By Mr. Drew, Penzance,—

Specimen of Schorly Granite, shewing Crystals of Felspár in a Quartz Vein, from Deep Point, St. Mary's, Scilly.

By Mr. Richard Pearce, Swansea,—

Specimen of Serpentine, containing Chromite (Chromic Iron), from the Lizard.

A Sample of the Chromite in a tube.

G. B. MILLETT,

Curator.

October 21st, 1870.

TREASURER'S STATEMENT.

RECEIPTS.

	£	s.	d.
To Subscription of His Royal Highness The Prince of Wales	20	0	0
„ Ordinary Subscriptions, Arrears, &c...	76	18	0
Balance due to Treasurer	150	6	7
	£247	4	7

EXPENDITURE.

	£	s.	d.
By Balance from 1868–9	44	1	4
„ Rates and Taxes	0	8	0
„ Housekeeper	6	10	0
„ Insurance	2	12	9
„ Expenses of Secretary and Treasurer..	4	3	0
„ Advertising	5	4	6
„ Sundry Bills	2	5	8
„ Subscription to Palæontographical Society	1	1	0
„ Books and Printing	43	13	10
„ Life Annuity to Miss E. T. Carne ...	20	0	0
„ Transferred from Building Account—Balance thereon	117	4	6
	£247	4	7

October 21st, 1870.

WM. BOLITHO, JUN.,
Treasurer.

LIST OF PAPERS READ AT ANNUAL MEETING

OCTOBER 21ST, 1870.

1.—The Secretary read a paper by Mr. Richard Pearce, F.G.S., a Member of the Society (absent), on Chromic Iron, in a Specimen of Serpentine, from the Lizard.

2.—Mr. T. Cornish presented some Hazel Nuts, found 18 feet below the marshy ground between Hayle and Marazion, described the strata in which they were found, and gave an imaginary sketch of the days before submersion and upheaval had altered the promontory of West Cornwall to its present shape.

3.—Mr. Cornish also exhibited some Specimens of Rock Sulphur, from a mine near Ancona, sent him by Captain Richards, of Redruth.

4.—Mr. Warington Smyth gave a detailed account of Gold Mining operations in Merionethshire from personal observation.

5.—Conversation as to the probability of the existence, or otherwise, of Gold in profitable quantities in the Quartz Veins of Cornwall, was carried on between Mr. Warington Smyth and Mr. T. S. Bolitho.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

FIFTY-EIGHTH ANNUAL REPORT,

&c., &c.

PENZANCE.

1871.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

Her Most Gracious Majesty The QUEEN.

Vice-Patron:

His Royal Highness the Prince of Wales, K.G., &c., &c.

Trustees:

Thomas S. Bolitho, Esq.
John S. Enys, Esq., F.G.S.
Day P. Le Grice, Esq., M.A.

OFFICERS AND COUNCIL FOR 1870-71.

President:

Hugh Seymour Tremenheere, Esq., M.A., F.G.S.

Vice-Presidents:

Earl of Mount Edgcumbe.
G. L. Basset, Esq.
Augustus Smith, Esq., F.G.S.
C. Fox, Esq.

Treasurer:

William Bolitho, Jun., Esq.

Secretary:

John Hallet Batten, Esq., F.R.G.S., M.R.A.S.

Librarians:

Edward Hearle Rodd, Esq.
Charles Campbell Ross, Esq.

Curator:

George B. Millett, Esq.

Council:

The Officers of the Society.

J. St. Aubyn, Esq., M.P.
A. Lloyd Fox, Esq.
E. Bolitho, Esq.
T. S. Bolitho, Esq.
S. Higgs, Esq.
N. B. Downing, Esq.
T. R. Polwhele, Esq.
Day P. Le Grice, Esq.
A. P. Vivian, Esq., M.P.
W. Husband, Esq.
J. Roscorla, Esq.
T. Cornish, Esq.

PRESIDENT'S ADDRESS.

It may be in your remembrance that the topics to which I have invited your attention in my three previous annual Addresses have ranged themselves under two heads,—local and general.

Of the local subjects, one of the most prominent was that of Mr. Henwood's great work "On Metalliferous Deposits, and on the working of mines and their results, and on Subterranean Temperature," forming the 8th volume of our "Transactions." Mr. Henwood's first work, the 5th of our "Transactions," was confined to the metalliferous deposits, and several of the phenomena, of the mines of Cornwall and Devon. His second work embraces the result of thirteen years' labour in commenting on the corresponding phenomena in the mineral districts of almost the entire globe, on data to a great degree collected by himself. It has fallen to the lot of few Societies to have their "Transactions" enriched with two such works. This time last year I was able to announce that this 8th volume was nearly ready, and I ventured to anticipate for it a very cordial reception from the public. That anticipation has been most fully realised. It has been received with one chorus of approval by the portion of the press which speaks the opinions of the scientific world.

The terms in which it has been described are that it is "a stupendous storehouse of facts," "an exhaustive memoir," that it displays "a most extensive scientific knowledge, and a thorough acquaintance with the pratice of mining," that it is "the most valuable work on the condition of mineral deposits that has issued from the press," and that it "is destined to form the starting-point from which, in the future, will be worked out important generalisations, which will render the search for metalliferous minerals far

less speculative than it has hitherto been." These are the opinions formed of the book by the "Mining Journal" and other daily and weekly organs of the press.

But within these two days another most weighty tribute to the character of the work has been paid by the very highest authority —the "Geological Magazine," in its number for this mouth; the initials to the article being those of one of the first authorities on this subject in the land. The writer affirms that Mr. Henwood's works "will form a foundation upon which the theorist can erect his edifice." After saying that "Science, in all its branches, owes much to those who devote themselves to the hard practical work of accumulating and recording the minutest details of phenomena coming immediately under their own observation, and who concentrate the whole power of their intellect upon such work," he mentions "the minuteness of detail and acuteness of observation which characterise every page of the book," and adds that "they must be studied, and thoroughly too, to be properly appreciated, by all interested in so important a subject as the progress and economy of mining."—T. D.

I think you will allow, after hearing these extracts, that I am fully borne out in saying what I did just now, that it rarely falls to the lot of any Society to have their "Transactions" enriched by such works. And I am sure I speak the unanimous feeling of the Society when I add that not only are our congratulations due to Mr. Henwood on the successful completion of his many years' labour, but our thanks for the additional distinction which his great works have conferred upon our "Transactions."

The question of who should be our publisher demanded the attention of the Council. Soon after our last annual meeting, after much careful inquiry we finally made arrangements with Messrs. Trubner and Co., of Paternoster Row.

As to the financial results that may be expected from the arrangement I will not anticipate the details which we shall receive from our Treasurer, but will merely mention, as bearing upon our future proceedings, that the sale of 150 out of the 200 copies at the

disposal of the Society will, at the nett price fixed upon, produce us very nearly enough to just clear off all our debt upon our building, and leave our future income free.

We shall then have spent upon, and paid for, this spacious and noble building of ours, the sum of about £3,750.

I am sure it will be the desire of every member of the Society that, having spent this large sum upon our building, we should proceed to put it to the best possible use. Two-thirds of it are at present unoccupied.

It has been my aim, in my previous addresses, to submit to your consideration the purposes to which it seems to me that it could be best applied, and I have laid before you the probable cost. I have shown that the fitting-up of our fossil-room, and adding a typical collection of fossils, in order to make it useful, in conjunction with our own excellent collection of Cornish fossils, for the purposes of instruction, would cost about £150, and the fitting-up our laboratory would cost about £50, in all about £200. Now these plans, which have in view the making this Society a centre of scientific instruction, I respectfully again commend to your investigation; and, if you approve of them, to your speedy adoption, on two grounds,—first, on that of our funds being now in so satisfactory a state that the Council could with confidence ask the Society for further contributions, to the amount stated, for a good object; secondly, that the object in question,—the encouragement of scientific and technical education,—is one which is now acknowledged throughout the length and breadth of the country to be of immensely-increased, nay, of vital, importance to the prosperity of the nation.

The successful conduct of such a course of instruction as I have, on former occasions, sketched out as suitable to this institution,—namely, mineralogy and geology, practical chemistry, mechanical science and the art of mining, trigonometry, natural philosophy, in particular the laws of fluid and elastic bodies,—would require the services of a first-rate teacher.

Now I wish to point out the resources which we have, and might have, by which we shall be able to command the services of such a

man. We should be able to offer him a certain salary, and also very commodious living-rooms adjoining those which would be appropriated to the laboratory; next, he would have the fees of the pupils, and the payments on results from the Science and Art Department, South Kensington; fourthly, I venture to anticipate that, in order to secure the advantage to the town of such courses of scientific instruction, the Corporation, or the Town Council, or perhaps both, would not withhold their co-operation.

And let me advert to one mode of co-operation still unused here, but which has been adopted with great success in many of the towns of the kingdom. By the "Public Libraries' and Museums' Act." of 1856, (18 and 19 Vict., cap. 70), Town Councils are empowered to levy a rate of 1d. in the £ for the establishment of public libraries and museums. Here is the last Parliamentary Return upon the subject, shewing the towns which, up to April, 1870, had adopted the Act, and giving a great number of particulars as to the manner in which they had been carried out, and the results. Twenty-six towns have adopted the Act, and of these thirteen have both libraries and museums. By the return from Northampton it appears that Science and Art classes have been established in connection with the museum. At Stockport a museum was first set on foot by private individuals, and then the powers of this Act were had recourse to for its support. At Warrington the same thing took place; the museum was established previously to this Act, but resort has been had to the Act for its support. These instances seem to shew that similar action is practicable in our case. Our museum is, under an arrangement with the authorities of the town, open to the public. I understand that a rate of a 1d. in the £ would yield £100 a year. This sum might be so apportioned as to afford material support to a free public library, and to the various scientific institutions of the town. The fact of a portion—even if but a small portion—of the income of such institutions being derived from a public local source gives additional strength and stability to such institutions. The sense of that stability encourages private contributions, of which

this return is full of instances of the most liberal kind. If, either from the Town Council under this Act, or from the Corporation, we could offer to a teacher some addition to what he would derive from us, and from his other sources of revenue above mentioned, we should, doubtless, secure the services of such an one as we could desire, who would be a master of those scientific and practical subjects which I have specified, and which together go to make up that technical education, of the need of which we are hearing more and more every year.

In such a county as this, little more need be said than has often been said already as to the importance of a wider diffusion of scientific instruction among those engaged in mining. Our friend here, Mr. Warington Smyth, than whom no one has had better opportunities of forming a sound opinion, has paid a just tribute to the Cornish miner, in saying of him that "by natural acuteness, and constant observation, he has obtained a thorough and satisfactory knowledge of a branch of his own craft;" that he has acquired "a constantly applicable judgment." No one aims to supplant that "sound practical knowledge," but to add to its power by all the available aids of scientific instruction.

This point has, I find, been strongly urged in a recent critical notice of Mr. Henwood's works, in which the writer says that "These volumes bear the most undeniable evidence of the imperative necessity of cultivating amongst our miners such an amount of scientific knowledge as will lead them to observe correctly those ever-varying phenomena which occur in the depths of the earth, and which, if recorded, would advance us to a knowledge of those laws by which the metalliferous deposits are regulated."

There has been lately a considerable movement in a large number of the principal towns in the kingdom in favour of a National University for industrial and technical training. In such a movement, Penzance, which has been termed "the intellectual capital of Cornwall," ought not to lag behind. The Educational Committee of the Town Council, in connection with the committee of

subscribers of the Science and Art Department, had addressed a memorial to the Geological Society, in which it was suggested that some commencement of their scheme of teaching might be made. The Council at the time were not able to respond favourably to the proposal; but it had been revived, and now it was asked that the laboratory might be used by Mr. Wright, of Penzance, a certificated teacher, for instruction in chemistry; and it was intimated that Mr. Bettany, of the same place, would be likely shortly to apply for the use of the fossil-room to commence a class in geology. No doubt the Council would give these projects all the assistance in their power. These facts bore a most favourable augury, for they shewed that there was a spontaneous movement in the direction which we desired. The current of public thought had changed. Years ago, to my own personal knowledge, the cause of technical education met with little favour in Northumberland and Durham; but this year, within six months, £27,000 and £2,000 a year had been raised in Northumberland and Durham to establish a college of physical science at Newcastle-on-Tyne.

Thus far on local topics. To revert to those relating to geology generally, and especially to the position and prospects of the science in this county, to which on former occasions I have invited attention, I have again to remark that we are still without evidence of its being pursued as a study among us to anything like the extent that we have reason to desire. A generation of distinguished contributors to our "Transactions" has almost entirely passed away, and but few successors are appearing to take their place. There was this that was noticeable and creditable in their case, that they did not find the practical pursuit of geological science incompatible with the demands of a profession or of business, or of public life. It may be alleged that when they began its pursuit there was greater novelty in it, and that it was then easier to extend its bounds. But no one can take up a number of the "Transactions" of the Geological Society without being struck with the fact that the novelties of the science are, if possible, more startling than ever, and that new knowledge is being accumulated

in every quarter of the globe. New facts are constantly modifying former conclusions,—contributing to the solution of unsettled problems,—and suggesting new ones. Let me advert for a moment to one instance. Look at the new interest given to many of those problems by the recent investigations into deep-sea life by the dredging operations in the abysses of the Atlantic. There will not be an individual henceforward who, being acquainted with what has been done there, takes up a bit of chalk, who will not experience a new pleasure; who will not feel a sense of enlargement of mind, of expansion of his imaginative faculties, with the effort to take in the wondrous sequence of ideas suggested to his thoughts. It has long been well known that the white chalk of our chalk-ranges that run for so many miles across our southern and eastern counties, is composed largely of microscopic organic débris; to such an extent that in some of our chalk a million-and-a-half of such remains are contained in one cubic inch. Now it is sufficiently astonishing to think of those miles upon miles of chalk hills, of hundreds upon hundreds of feet in thickness, being the product of the life and death of minute animals, chiefly small shell-fish. But what have these deep-sea dredgings disclosed to us? They have shewn that no less than 19 species of one of these small creatures *(Foraminifera)* that are found fossil in the chalk are now living in the abysmal mud of the Atlantic, and good grounds are shewn by Mr. Prestwich, in his anniversary address, as President of the Geological Society for the present year, for the conclusion that those lower forms of life have been continued there without interruption from the epoch of our chalk; that the chalk now forming in the depths of the Atlantic differs only in proportion of parts, and not radically from our own chalk, and that the admixture there of other genera of animal and vegetable life not found in our chalk is due to differences of temperature and other physical conditions. This is only one of the many new fields of inquiry that have been opened of late years, and which, in the words of Mr. Prestwich, "must exercise considerable influence on future geological speculation," and I have alluded to it in order to

enforce the fact that the attractions of the study of geology are in reality as great as they ever were, and perhaps even greater, in proportion to the greater breadth and certainty that the science has acquired.

Now I beg to call attention to a work, of which I believe I shall be borne out by those best capable of judging when I say, that it is more calculated to stimulate the study of geology than perhaps any book that has been published for many years. It is entitled "The Earth;" it is "a descriptive history of the phenomena of the life of the globe;" it is by "one of the most able living French authors," M. Elysée Reclus. The work was translated by the late Mr. B. B. Woodward, the Queen's Librarian at Windsor Castle, and has been edited by his brother, Mr. Henry Woodward, of the British Museum. It is a work on physical geography; and it is physical geography which has been rightly said "to open out the path for geology to travel over." To make out the history of the older physical geographies of the world is, in the words of Professor Ramsay, "one of the ultimate aims of geology." And as "the present physical geography of the world is but the sequel of the older physical geographies," a comprehensive view of the physical geography of the present time is of the highest value towards comprehending the changes which the earth has undergone in past ages. The "great task" of giving this comprehensive view the editor says that M. Reclus "has attempted and achieved with wonderful success." I have great pleasure in presenting a copy of this work to the Society, and I trust it may attract many readers. It satisfies the want which every student of geology is apt to feel, the desire to know the relation of the particular facts that come under his eye to the vast generalizations which have resulted from the aggregate knowledge gathered from all quarters of the world. This knowledge, collected with immense research, M. Reclus has put together in a most luminous and harmonious manner, and has, as it were, subjected it to the eye by illustrations said to be "unsurpassed in number and excellence" by any similar work. Here is one, of peculiar interest to us in this corner of our island. It is

a map of the upheavals and depressions on the whole surface of the globe. That the upheavals are numerous, the great mountain chains tell us. But few persons realize the idea of how many and extensive are the areas where great depressions have taken place, on land, but chiefly in the sea-bottoms. This map shews you them all at a glance. They are for the most part, although not in close conjunction with, yet not far from the sites of the existent and extinct volcanoes of the world, the immense number of which, chiefly either on the margin or rising out of the great waters of the globe, may be seen on this other map in the same volume. (Pp. 616 and 504.)

Now who among us has not listened, with perhaps a somewhat incredulous wonder, to the tradition which we have heard from our childhood, of the Land's End having been once connected with the Scilly Islands by the tract of country called Lionesse, and of its submersion, with all its inhabitants, in a night? Who does not know that our St. Michael's Mount used to be described as "the hoar rock in the wood," and that the roots of the primeval forest have been, at times, found, in situ, beneath the sands of our shore; —a paper on which is about to be read to us this very day? Nay, who has not heard of the tradition, mentioned by Plato, of the vanished land of Atlantis, that once connected the Eastern and Western Hemispheres? Nothing more probable than these traditions! This book has put together the records of all such changes, and it is astonishing to see how vast they are. The ground is sinking "continuously and imperceptibly" in parts of Egypt, along the shores of the Adriatic, on the coasts of Brittany and Normandy, in Flanders and Holland, on the eastern coasts of Schleswig and Holstein, all round the southern basin of the Baltic. In 1819 occurred what is well denominated "the great geological catastrophe," of the sudden subsidence of the Runn of Cutch, "over an extent of some thousand square miles." On the American Continent large tracts of Brazil and of the countries further south are "imperceptibly sinking;" also parts of Georgia and South Carolina, of the State of New York, and the shores of the Bay of

Delaware, which are calculated to lose "nearly eight feet a year." The gradual subsidence of Greenland is described as being "much more rapid." A gradual subsidence is taking place along a line that "extends diagonally across the Pacific for more than 9,000 miles with an average width of 1,200 miles. (P. 659.) And when we ask how comes all this about, we find the ready answer in the fact that all over the earth's surface there are vast corresponding upheavals gradually and constantly going on. "Great movements of elevation are in progress all round the coasts of the Bay of Bengal, in the Indian Archipelago, and in the Chinese seas, over a large portion of the American continent, in a part of Africa, in a portion of Australia and in New Zealand, in Scandinavia, in the Mediterranean regions, and in the coasts of Europe. 'In New Zealand the shores of Lyttelton have risen three feet in ten years. On this great subject I cannot resist the temptation of reading to you one eloquent passage of M. Reclus's, in which he sums it all up:—

"The solid ground, which people once considered the symbol of immobility, is, on the contrary, in a state of constant oscillation. The crust of the earth, carved out incessantly by the various meteorological agents on one side, drawn by the other bodies revolving in space on the other, modified by water and pressed upon by vapours, gases, and molten matter, never ceases to undulate as a raft rising and sinking on the waves of the sea. At rare intervals there are great earthquakes; more often this undulation of the ground consists in mere vibrations, which are scarcely perceptible except by the aid of instruments. The terrestrial crust is not only continually shaken by these transient shiverings; it is, besides, actuated by uniform movements of incalculable force, which at some points raise it, and at others depress it, as compared with the level of the sea. Whilst we are busy on its surface, the earth itself is shifting under our feet." (P. 616.)

These "slow and majestic oscillations" go on without throwing the earth into confusion by any violent revolution; continents rise and sink, as M. Reclus beautifully says, "without disturbing the

flight of the gnat." The ever-moving phenomena

> "Change like the world's great scene, where without noise
> The rising Sun night's sombre light destroys."

Here is ample scope for the labours of the geologist for many a day,—the sublime one of endeavouring to discover the general law of these regular oscillations, which M. Reclus points out are distinguished from volcanic movements "by their excessive slowness as well as by their character of generality." They are, he believes, "determined by causes affecting the whole mass of the planet." He thinks they have their "regular cycles;" only the reason of these secular tides remains unknown. He thinks that some day, when scientific men have observed all the lines of level on sea-coasts and mountain-sides, and all the débris that have been left by the sea, they may be in possession of the materials for precise measurements of the dimensions of each wave of upheaval and of the impulsive forces which actuate them.

These elevating considerations may give a further idea of the problems remaining to be solved, and shew, as M. Reclus urges in many passages, "what grandeur there is associated with the labour of the geologist," every advance made by him in the knowledge of existing phenomena "rendering easier some victory of the human intellect over the past history of the globe." He reminds us, however, that without the aid of physical geography, "it would have been impossible even to have ventured the initiative step into the labrynth of vanished ages."—(Pp. 37, 39). This is my excuse for having drawn attention to this book, and for commending its study.

One word more as to the plan of the work. It treats first of the Earth as a planet; then of the land; then of the circulation of water; and lastly of subterranean forces. All the principal known facts on each subject are artistically brought together and presented in a style of remarkable clearness and elegance. One instance of the breadth and comprehensiveness of those facts I may allude to, as illustrating the question of the subsidence of large masses of the earth's crust, such as I have adverted to as a

matter of interest to us here. After enumerating various instances in which an approximate calculation has been made of the many millions of cubic yards of volcanic matter thrown out by various volcanoes, he mentions two, one of which, Skaptar, in Iceland, threw up in 1783, "a mass equivalent to the whole volume of Mont Blanc," (655,000 millions of cubic yards), and Timboro, near the Island of Java, which threw up in 1815 a mass which was "said to be equivalent to thrice the bulk of Mont Blanc."—(Pp. 544, 550). That the infiltration of sea-water has a great deal to do with the formation of those gases which exercise such prodigious power, is proved by the fact of marine salt and the various compounds of soda and potash entering largely into the composition of the lava of volcanoes near the sea. Whether the composition of the lava of eruptions that take place far inland is the same has not yet been determined. And although it has been calculated, on data, M. Reclus says, more or less hypothetical, that the expansive force capable of lifting these weights must have "come from a depth of more than nine miles below the surface of the ground," geologists "confess their ignorance on this point;" but nevertheless it may be expected that the progress of science may, sooner or later, explain to us "these phenomena which are taking place in the interior of our globe," which at present "are not better known to us than the phenomena of the lunar volcanoes." Even the origin of the granite which surrounds us here on all sides at no great distance, is quite undetermined It has been found that the former theories as to its production cannot be maintained, and nothing conclusive has yet taken their place.—(P. 512).

I have adverted to "the victories which the human intellect may yet attain over the past history of the globe;" and I have alluded to the fact that M. Reclus, in introducing the subjects of physical geography and geology, impresses on the mind their grandeur by a preliminary review of the wondrous phenomena of the earth as a planet. He reminds us that it is a mere globule in the immensity of space, a mere satellite of the sun, the volume of which is a million-and-a-half times greater; and that its speed of

diurnal rotation is at the Equator eighteen miles a minute, (at Paris eleven-and-a-half miles a minute), its mean speed through space in its annual revolution round the sun nineteen miles in a second, (or sixty times the speed of a cannon-ball), while its "enormous translatory movement,"—a movement "not many years ago entirely unknown," dragging it "through endless tracts of space in the train of the sun," is going on with an inconceivable rapidity, "at the rate of forty-four miles in a second," being no less than 1,382 millions of miles in one year, in the direction of the constellation of Hercules, towards some centre of gravity supposed to be common to many stars.

These movements, of which we are all unconscious,—

"Bearing us soft with the smooth air along,"

are such as, in the words of the famous author of the Religio Medici, "to confound the imagination." Yet they have been brought to light by the observations of science; they are part of the conquests of the human mind, accepted on proofs which come within its legitimate sphere. How this planet of ours was formed is a matter still "lost in the dark night of our ignorance." Nevertheless, being a physical problem, modern research, and especially the recently acquired power of "spectrum analysis," may one day throw great light upon it. Already of late years Laplace's theory of the condensation of the whole planetary system from gaseous particles, which he himself put forward "with diffidence," and the idea of a central mass of molten matter with a refrigerated crust only between us and it, have been rudely shaken by more recent astronomers, and the hypothesis which appears now to be most accepted is that "there is no actual central fire, but only internal seas of red-hot molten matter scattered about in various parts of the inside of our planet, situated not far from the surface of this earth, and separated from one another by masses of solid strata." —(P. 23). But when, from the determination of material facts, speculation proceeds to investigate the immaterial, the legitimate bounds of philosophical investigation are soon overpast. How life first appeared upon earth, how intelligence, whether instinct or

mind, came to act upon matter, or matter upon mind, are problems that soon bring us to that "insuperable line" which finite beings may attempt to pass, but in vain. Milton refers to the wholesome desire of "knowledge within bounds," and adds—

> . . . . "Beyond, abstain
> To ask; nor let thine own inventions hope
> Things that the Omniscient has suppressed in night;
> Enough is left besides to search and know."

Vainly may modern inquiry trace the chain of connexion betweeen the present and the past up to the most elementary fact of matter or of mind; it must come ultimately to some beginning, some primitive impulse for which human knowledge affords no solution; and if it dates the development of all visible and invisible things from that primitive impulse, it only adds to the wonder attaching to all that vast subsequent development, and stlll leaves the cause unexplained. What Lord Bacon observed in his time is doubly trne in this; the contemplation of secondary causes is apt to lead the scientific inquirer to an unwillingness to admit the existence of a Great First Cause. He adds, "Let no one think that through the contemplation of nature, we can penetrate the Divine mysteries." Let us, in our geological sphere, while tracing the marvellous development of life through unnumbered past ages, and the as wondrous proofs of adaptation and contrivance and beauty throughout the whole of it, be content to acknowledge, with Milton, that it was the Omniscient who "the vital virtue infused," that His is this

> "Universal frame,
> "Thus wondrous fair; Himself how wondrous then,
> "Unspeakable."

I have now to turn to the subject of the losses which our Society has experienced during the year.

The most conspicuous among our ordinary members who has been removed from us by death is Sir Thomas Acland, Bart., of Killerton, Devonshire, for many years M.P. for that County. Some of his Cornish property was near one of our mining centres, and, recognising the fact of the bearing of this Society on the

development of the mineral wealth of the county, he was a contributor to our funds for a considerable number of years. It is a most remarkable circumstance in the public career of Sir Thomas Acland that a statue was erected to him in his life-time. It stands beside the walls of the old Castle, at Exeter, within which, in the long course of his magisterial duties, he was wont to devote himself to every measure of public usefulness or private benevolence that made their demands upon him. On the pedestal of that statue is engraved the well-known line of Horace,

"Præsenti tibi maturos largimur honores."

The idea and the act, which were questionable in the case of the Roman people towards Augustus, when adopted by the enlightened magistracy and the independent community of Devonshire gave visible expression to a compliment which it is the lot of few men to enjoy. The Latin poet, following up the strain of praise, tells his countrymen that they never had an object so worthy of their admiration before and never would again. "Nil oriturum alias nil ortum tale fatentes." That is not the feeling with which in this country we mark the passing away of a man who has worthily fulfilled the duties of his position. Happily we are never without a succession of such men; to each in his turn the public gratitude applies the words of the poet, "Agnosco procerem," in recognition of their having responded to the often onerous calls which demand of them that they should take a leading place whenever any good is to be done.

Mr. William Hustler, also one of our ordinary members, at one time one of our Vice-Presidents, was for many years engaged in developing the tin mines of Spain. He was a nephew to my predecessor in this Chair, Mr. Charles Fox.

Of our honorary members we have to regret, in common with the scientific world, the removal from among us of Sir Roderick Impey Murchison, Bart., &c., &c., whose eulogy is written in the triumphs of geological science extending over half-a-century. His laborious works, his great discoveries, his happy previsions, (such as that of the existence of gold in Australia), will hand his fame

down to the latest ages; and no one who ever came in contact with him will, while this generation lasts, ever forget his kindly courtesy, and the many other admirable qualities which endeared him to the immense circle of his personal friends.

We have also lost Sir Proby Cautley, another of our honorary members of great distinction. We are indebted to him for many valuable specimens collected when, in conjunction with his friend Dr. Hugh Falconer, he was examining the geology of the Sewalik Hills, Upper India. He was for many years a member of the Council of India.

The last subject to which I have to advert is, that the time is arrived for my laying down the office of President of this Society. By our rules, the President is elected for two years. I have, by your favour, held the office for two terms. Several of my friends around me kindly urged that I should allow myself to be re-elected. While most sensible of the compliment implied in that wish, I declined acceding to it, on the ground that I thought the interests of the Society would be better served by my giving place to another. I never, as you know, made any pretension to being a practical geologist, and the only justification for my being elected to this office at all was the hope that, as I had been for so many years publicly connected with the Education question, I might, possibly, be of some service towards suggesting the means of making this Society an instrument for promoting the study of geology and certain other branches of scientific instruction, for which our spacious building and our collections afford facilities that might be of great benefit to the country at large.

I have, to the best of my ability, laid before you, in my successive addresses, my thoughts and suggestions on that subject. It would, I feel assured, be best for the society that those plans which I have ventured to sketch out should be subject to the consideration and judgment of another president. We have the happy prospect of obtaining one whose qualifications for such a post are second to no one who could be named for it. Mr. Warington W. Smyth has consented to be nominated as my successor. We all know that he

held a few years ago the distinguished position of President of the Geological Society. He has lately come among us at a resident in our neighbourhood for a portion of the year, and he has, as you are aware, been long connected with the County as representing in it the interests of the Duchy mineral property. Of the high place he has acquired in the ranks of men of science it is not right that I should speak in his presence, but it is open to the world to know, as evidenced by his presidential address to the Geological Society in 1868, that his attainments in the field of geology are second to none, while his knowledge of all that relates to practical mining embraces the experiences to be gleaned both in this country and on the continent to an extent very well known.

That, with the immense demands which Mr. Warington Smyth has upon his time, he should have kindly yielded to the urgent desire of our Council that he would consent to be nominated to this Council for election as President is a matter demanding the warmest thanks of the Society. There are several matters upon which his advice and assistance will be of great value to us, beyond those which I have already mentioned; the most prominent of them being the question which I have touched upon in former addresses —the possibility of our bringing about some kind of amalgamation between this Society and the Miners' Association, for the promotion of Scientific Education—a question which the present more favourable state of our funds will, I trust, soon justify our entertaining in earnest and with a fair prospect of success.

It now only remains for me to record, in a few words in this my last address to you, my deep sense of the kindness with which you have overlooked my short-comings as President, and favourably interpreted my cordial desires to make myself, if possible, a little useful to the Society; and I can assure my successor that he will find in no Society with which he may become connected men more accustomed, uniformly, to put aside all narrow feelings, to smooth down all possible asperities, and to look with a single eye to the welfare and credit of the Society whose interests they have in charge.

THE FIFTY-EIGHTH ANNUAL REPORT OF THE COUNCIL, 1871.

THE Council are glad to report on this, the Fifty-eighth Anniversary Meeting, the continued prosperity of the Society. The work of arrangement in the Museum has been steadily going on under the kind assistance afforded to the Curator, which the Council has so often acknowledged; and considerable progress has been made in the formation of a Catalogue of Specimens, hitherto a great desideratum.

The resort of visitors to the Museum during tne past year has been very remarkable, no less than 942 having recorded their names; but in reality these figures are far from shewing the actual number of persons who have entered the room and examined our mineral treasures. Among men of note, the name of Sir C. Lyell appears, and there is reason to believe that the visit of that illustrious geologist to this part of the country will be found to have been productive of interesting scientific results, and also of benefit to this Society itself. One visitor, viz., Mr. W. B. Beaumont, the well-known M.P. for Northumberland, has shewn his appreciation of the Society's Museum by a munificent present of Lead Ores, and the preparations therefrom, which forms the most conspicuous item in our Curator's list, and the display of which adorns our presentation case. Professor Wagner, of Philadelphia, has fulfilled his promise alluded to in a previous Report, and sixty-eight admirable specimens of American minerals have been added to the Society's collection.

Nothing further has been done to elucidate more fully the precise character of the Cornish fossils contained in our Peach

Cabinet, but their donor is still active in pursuing the subject, which fills so many pages of our "Transactions;" and the paper, which will be read to-day, shews that his interest in Cornish Geology remains unabated.

The contributions to our Society's Library continue to be most valuable, and the Council hope, with improved financial resources, that they will be enabled henceforth to set apart a regular fixed sum, for the binding of the periodical publications received from scientific bodies in Great Britain, France, America, India, and Australia; and for the purchase of new and valuable works. The Council are gratified in announcing that the latest gift to the Library is an "Essay on the Rocks developed by the Tunnel through the Western Alps," by Mons. Elie de Beaumont, the eminent French Academician, and one of our own Honorary Members,—from the Author.

Undoubtedly *the* event of the year has been the actual publication of Mr. W. J. Henwood's important work on Metalliferous Deposits, forming the 8th Volume of the Society's "Transactions," the completion of which was announced last year. This work will add greatly, not only to the scientific reputation of its Author, but also to that of this Society throughout the civilized world. Here, too, it is proper to remark that Mr. Henwood, dissatisfied with some of the lithographic plates, has replaced them by others at a cost to himself of upwards of £15, and has also very liberally waived any claim to privileges sometimes accorded to authors of papers published in the Society's "Transactions."

The Report of the Treasurer will shew that the financial position of the Society is healthy; and that, although considerable charges have been necessarily incurred during the past year in connection with the publication of "Transactions," the re-fitting of the Society's rooms, with improved blinds and the renewal of painting,—the prospect of freedom from debt, and of the possession of means to increase the utility of the Society, is becoming more and more encouraging.

The President's Address relieves the Council from the duty of

dwelling upon the losses which the Society has incurred by the death of Ordinary and Honorary Members during the year. Of course this Society, in common with the whole World of Science, laments the death of the illustrious Sir Roderick Murchison; and they may mention that the late Sir Proby Cautley, so long ago as 1836, presented to this Society the Sub-Himalayan Tertiary Fossils, which now fill one compartment of our lower cases,—and that the splendid illustrations of his own and the lamented Falconer's labours in the field of Indian Geology, as shewn in the volumes of the "Palæontologia Sivalensis," form a part of our Library.

The Minute Book proves that the Council have done *their* duty in recording their acknowledgment of the valuable services rendered to the Society by the President, Mr. H. S. Tremenheere, and their regret at his resignation; and also in taking steps for the election of Mr. Warington Smyth as his successor. It remains for the Meeting to endorse the sentiments and confirm the proceedings of the Council, in regard both to the out-going and in-coming President.

(Signed)

J. HALLET BATTEN,

Secretary.

November 3rd, 1871.

LIBRARIANS' REPORT.

THE following Periodicals have been received since the last Annual Meeting, (held October 21st, 1870.)

1.—Philosophical Magazine for 1870-71.
2.—Reports of Mining Surveyors and Registrars, Victoria, 1870-71
3.—Quarterly Journal of the Geological Society.
4.—Proceedings of the Royal Society.
5.—Western Chronicle of Science.

DONATIONS TO THE LIBRARY.

1.—From Mr. Warington W. Smyth,—
Lectures on Mineralogy and Mining.
Catalogue of British Section of Paris Exhibition, 1855.
Ditto ditto ditto 1867.

2.—From Doctor Pascucci,—
Brevi Cenni Sulle Specialitá Mattei, &c.

3.—From the late Sir James South,—
Copy of Sir Humphry Davy's Treatise on the Safety Lamp.

4.—From Professor T. Tennant, (Author),—
Pamphlet on South African Diamonds.

5.—From Mr. Wm. Hosken Richards,—
Abstract of Weather at Penzance and Neighbourhood, 1870.

6.—From Secretary Natural History Society of Dorpat, Russia,—
Two Volumes of Transactions, and Pamphlets, and Proceedings.

7.—From Professor Josiah P. Cooke, jun., U.S. (Author),—
Absolute System of Electrical Measurements.

8.—From President of Geological Society, London,—
Address at Anniversary Meeting, 1871.

9.—From M. Dunod, Paris, (Editeur, &c.)—

1.—Annales des Mines, Vol. XVII.

2.— Ditto XVIII., XIX., XX.

3.—Catalogue of Works, Ancient and Modern.

10.—From Mr. W. J. Henwood, (President)—

Address to the Royal Institution of Cornwall, Spring Meeting, 1871.

11.—From Government of India,—

Memoirs and Records of Geological Survey of India.

12.—From Mr. Warington W. Smyth,—

Transactions of North of England Institute of Mining and Mechanical Engineers.

13.—From Messieurs Deleise and De Lapparent, Paris,—

Revue de Géologie pour les Années, 1867-1868.

14.—From Mr. Wm. Whitaker, (Author),—

1.—On the Chesil Bank, Dorset, and Raised Beach at Portland.

2.—On Geology and Consumption.

3.—On Sub-Aerial Denudation, &c., &c.

4.—On the Chalk Cliffs between Seaford to Eastbourne.

5.—List of Works on the Geology, Mineralogy, &c. of Devon.

15.—From M. Elie de Beaumont, Member National Institute, France,—

Memoir on the Rocks penetrated by the Tunnel through the Western Alps.

16.—From Mr. J. Jope Rogers, of Penrose,—

An interesting Contribution to the Archives of the Society in the form of a File of Correspondence referring to the earlier years of its existence.

The following Societies have forwarded to us their Reports, Proceedings and Transactions:—

1.—The Leeds Philosophical and Literary Society.

2.—The Geologists' Association.

3.—The Bristol Naturalists' Society.

4.—The Miners' Association, Cornwall.

5.—The Royal Cornwall Polytechnic Society.
6.—The British Association, 1870.
7.—Smithsonian Institution, Washington.
8.—Connecticut Academy of Arts and Sciences.
9.—American Philosophical Society, Philadelphia.
10.—Royal Society of Victoria.

We have received the following Miscellaneous Vols. :—

1.—The Palæontographical Society.
Volume XXIV (1870), in five parts.
2.—Report of the Commissioners of Agriculture, Washington, U.S.
3.—Cox's Geological Survey of Indiana, 1869.

E. H. RODD, } *Librarians.*
C. C. ROSS, }

November 3rd, 1871.

CURATOR'S REPORT.

DURING the past year the following presentations have been made to this Society.

By Mr John Hallet Batten,—

A piece of Mahogany perforated by Teredo. Drifted on shore opposite the Royal Baths, Penzance, 25th November, 1870.

By Mr. Augustus Smith,—

Fossil Oysters, from the Banks of the Parana River, in the Argentine Republic, very near the City of Parana; about 100 miles above Rosano, and 500 miles from the Sea, in Lat. 31-41 South, and 63-25 West. The layer of Shells is 15 feet below the level of the surface, and 30 feet above the level of the River.

By Mr. Thomas Cornish,

Specimen of Clay-slate perforated by Pholas parvus, from Long Rock, Mount's Bay.

By Mr. Frederic Anthony Potter, Crownford, Derbyshire, Honorary Member of this Society,—

Two Blocks of Syenité, from the Mount Sorrel Granite Quarries, Leicestershire.

By Mr. John Murphy,—

Large piece of Oak Wood, from the Submarine Forest, Lariggan, Mount's Bay.

By Captain Hosken, Indian Army,—

Specimen of Crystals, from Central India.

By Miss Crawford,—

Two small Specimens of Rubies, from the Cape of Good Hope.

By Mr. Henry Skewis, Brendon Hills, near Taunton,—

Two Specimens of White Spathic Iron.

By Mr. Michael Beazeley, Penzance,—

A Specimen of Porphyritic Phonolite, from the Wolf Rock.

By Messrs. John Freeman & Sons, Penryn,—

Two blocks of Polished Granite, from Carnsew and Lamorna, (as bases for the busts of Mr. Davies Gilbert and Sir Charles Lemon.)

By Mr. William Whitaker,—

Specimens of Flints, from near Tol-peden-Penwith, and St. Just Downs.

By Mr. Wentworth Blackett Beaumont, M.P. for Northumberland,

A Collection of Specimens of Lead Ore and Lead, from the Mines at Allenheads, Northumbland, "illustrating the various stages of progress from the excavation of the ore and its matrix in the mine, through the several operations of dressing and smelting, to the formation of Pigs of Lead, ready for the market." With a descriptive Catalogue, by Mr. T. Sopwith, F.R.S.

1.—Laminated Bouse.
2.—Slickensides on Fluor Spar.
3.—Ordinary Bouse.
4.—Picked Galena.
5.—Bouse. (Small-sized.)
6.—Breakings. (Selected ordinary Bouse.)
7.—Cuttings or Waste.
8.—Crushed Bouse.
9.—Chatts.
10.—Sieve Ore.
11.—Undressed Smiddum.
12.—Smiddum Ore.
13.—Undressed Slime.
14.—Dress Slime, obtained by manual labour.
15.—Dressed Slime, obtained by means of Mr. Brunton's patented invention.

16.—Dressed Slime Ore.
17.—Roasted Lead Ore.
18.—Grey Slags.
19.—Black Slags
20.—Crystals of Selected Lead.
21, 22 and 23.—Fume.
24.—Round Litharge.
25.—Timsed Litharge.
26.—Skimmings.
27.—Lead, Small pig made from roasted lead ore.
28.—Ditto, Ditto of Grey Slag Lead.
29.—Ditto, Ditto of Selected Lead.
30.—Ditto, Ditto of Common Lead.
31.—Ditto, Ditto made from ore-hearth fume.
32.—Ditto, Ditto of Calcined Common Lead.

By Mr. William Wagner, President of the Wagner Free Institute of Science, Philadelphia, and Hon. Member of this Society,—

A Collection of Specimens of American Minerals.

1.—Kakoxene (Phos. Iron), from Stirling, New Jersey.
2.—Limonite, Ditto ditto
3.—Phosphate of Lime, (3 specimens) Northern New York.
4.—Pargasite, Rossie, New York.
5.—Anthracite Coal (Pavonine), Schuylkill County, Pennsylvania.
6.—Franklinite, Sterling, New Jersey.
7.—Anthracite Coal, same as above.
8.—Ditto, ditto, (Large Specimen.)
9.—Novaculite, Little Rock, Arkansas.
10.—Elastic Sandstone, (rare,) North Carolina.
11.—Agaric Mineral, Watertown, New York.
12.—Nickel, from Vermont.
13.—Carbonate of Lime, Rossie, New York.
14.—Red Oxide of Zinc, (2 specimens), rare, New Jersey.
15.—Scapolite, (2 specimens), Goreneur, New York.
16.—Nickel, (2 specimens), Canada.

17.—Deweylite, Maryland.
18.—Analcime, Nova Scotia.
19.—Adularia, Delaware County, Pennsylvania.
20.—Franklinite, Sussex County New York.
21.—Native Copper, in Trap-rock, from Lake Superior.
22.—Crystals of Titanium, (2 specimens), rare, Chester County, Pennsylvania.
23.—Crystals of Analcime, with radiating Zeolite, Bay Fundy.
24.—Crystals of Corundum, (2 specimens), rare, Chester County.
25.—Cryolite with Lead, Copper, and Pennsylvania Zinc, from Greenland.
26.—Clinoclore, Chester County, Pennsylvania.
27.—Phrenite, Charleston, Massachusetts.
28.—Williamsite, Chester County, Pennsylvania.
29.—Analcime, Nova Scotia.
30.—Kyanite, Chester, Massachusetts.
31.—Stilbite, with Heulandite, Nova Scotia.
32.—Chloride of Calcium, (2 specimens), New York.
33.—Quartz on Agate and Jasper, Brazil.
34.—Ditto ditto ditto, Stalactite.
35.—Stilbite, Nova Scotia.
36.—Nickel, (Sulphuret), 2 specimens, Central Pennsylvania
37.—Phosphate of Lead, Chester County, Pennsylvania.
38.—Quartz on Agate, Brazil.
39.—Tourmaline, Pennsylvania.
40.—Cryolite, Greenland.
41.—Red Oxide of Zinc, Sussex County, New Jersey.
42.—Precious Serpentine, Chester County, Pennsylvania.
43.—Sulphuret of Silver, Colorado.
44.—Sillimanite, Chester, Connecticut.
45.—Mica, Siberia.
46.—Mica, beautifully crystallized, Connecticut.
47.—Sulphate of Lime, from St. Mary's, Maryland.

48.—Sulphur passing into Selenite, Sicily.

49.—Carbonate of Zinc, of which Zinc white paint is manufactured, from Bethlehem, Pennsylvania.

50.—Selenite, from Nova Scotia.

51.—Gold, from Utah.

52.—Sulphuret of Silver, Utah.

53.—Fluoride of Calcium, (6 specimens), from Muscotongo Lake, near Lake Ontario, New York.

By Mr. Robert Sheriff, of Glasgow,—

Seven Specimens of Scotch Granite.

By Mr. Richard Pearce, of Swansea,—

A Specimen of Pitch Blende or Oxide of Uranium, from Russell District, Gilpin County, Colorado Territory.

By Mr. Samuel Higgs, (from North Levant Mine, St. Just),—

Four Specimens of Tin crystallized on Crystals of Quartz.

By Mr. Warington W. Smyth,—

A Specimen of Hematite Iron Ore, (Red Sesquioxide), from Cleator Moor, near Whitehaven, Cumberland.

By Mr. Warington W. Smyth,—

A Specimen of Coked Coal, exhibiting Columnar structure, taken 3 feet from the wall of a Whinstone Dyke in Camboise Colliery, Northumberland.

By Mr. C. W. Peach,—

A Specimen of Glaciated Quartz, from Carn Gorran Haven, Cornwall, and a specimen of the same, from the House of Eriboll, Sutherlandshire.

By Mr. Nicholas Whitley,—

A Map shewing the strike of the Beds of Slate in Devon and Cornwall.

G. B. MILLETT,

Curator.

November 3rd, 1871.

TREASURER'S STATEMENT.

RECEIPTS.

	£	s.	d.
To Subscription of His Royal Highness The Prince of Wales	20	0	0
„ Ordinary Subscriptions, Arrears, &c...	77	9	0
Received on account of Vol. 8 of Society's Transactions	26	5	0
Balance due to Treasurer	186	11	0
	£310	5	0

EXPENDITURE.

	£	s.	d.
By Balance from 1869–70	150	6	7
„ Rates and Taxes	0	8	0
„ Housekeeper and Coals	7	9	6
„ Insurance	2	12	9
„ Expenses of Secretary and Treasurer..	5	1	4
„ Advertising	3	16	0
„ Subscription to Palæontographical Society	1	1	0
„ Books and Printing	51	9	6
„ Life Annuity to Miss E. T. Carne ...	20	0	0
„ Sundry Bills	25	8	11
„ Balance to J. Mathews on Building Account	42	11	5
	£310	5	0

November 3rd, 1871.

WM. BOLITHO, JUN.,
Treasurer.

LIST OF PAPERS READ AT ANNUAL MEETING,

NOVEMBER 3RD, 1871.

1.—Notes on the Geology of Mount's Bay, by Mr. Nicholas Whitley, Honorary Member of the Society, illustrated by a Map,—read by his son, Mr. Daniel Whitley.

Mr. T. Cornish, when commenting on this Paper, shewed a section of ground cut through at the Gas Works, Penzance, with Specimens of the Strata.

2.—A Note of Mr. Richard Pearce, of Swansea, Member of the Society, explanatory of his Present to the Museum of a Specimen of Uranium, picked up by himself in Russell District, Gilpin County, Colorado,—was read by the Secretary.

3.—A Paper on Traces of Glacial Action on the Great Cairn, near Gorran Haven, Cornwall, illustrated by Specimens, by Mr. C. W. Peach,—was read by the Secretary.

4.—Mr. Warington W. Smyth, President Elect of the Society, gave an oral explanation to the Meeting of the peculiarities of a specimen of Coked Coal, exhibiting columnar structure, which he had taken from the vicinity of a Whinstone Dyke, in Camboise Colliery, Northumberland.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

Her Most Gracious Majesty The QUEEN.

Vice-Patron:

His Royal Highness the Prince of Wales, K.G., &c., &c.

Trustees:

Thomas S. Bolitho, Esq.
John S. Enys, Esq., F.G.S.
Day P. Le Grice, Esq., M.A.

OFFICERS AND COUNCIL FOR 1871-72.

President:

Warington W. Smyth, Esq., F.R.S., F.G.S

Vice-Presidents:

Augustus Smith, Esq., F.G.S.
Hugh Seymour Tremenheere, Esq., C.B., F.G.S.
John St. Aubyn, Esq., M.P.
Sir Richard R. Vyvyan, Bart., F.R.S.

Treasurer:

William Bolitho, Jun., Esq.

Secretary:

John Hallet Batten, Esq., F.R.G.S., M.R.A.S.

Librarians:

Edward Hearle Rodd, Esq.
Charles Campbell Ross, Esq.

Curator:

George B. Millett, Esq.

Council:

The Officers of the Society.

T. S. Bolitho, Esq.
T. Cornish, Esq.
N. B. Downing, Esq.
Robert Fox, Esq.
D P. Le Grice, Esq.
S. Higgs, Esq.
W. Husband, Esq.
John Roscorla, Esq.
W. Bickford Smith, Esq.
Col. Tremayne.
A. P. Vivian, Esq., M.P.
J. M. Williams, Esq.

LIST OF THE MEMBERS, OCTOBER, 1872.

Honorary Members.

George James Allman, M.D., F.R.S., late Prof. Nat. Hist. University of Edinburgh, M.R.I.A.
M. L. Elie de Beaumont, Perpetual Secretary of the Institute of France, Paris.
M. Becquerel, Member of the Institute of France, Paris.
Mr. W. H. Benson, Aix la Chapelle.
Henry S. Boase, M.D., F.R.S., F.G.S., &c., Dundee.
M. Ami Boué, M.D., Vienna.
Mr. J. Bowman, London,
James Bryce, M.A., LL.D., F.G.S., &c., Glasgow.
Josiah P. Cooke, Professor of Chemistry, &c., University of Cambridge, United States.
Mr. John F. Cunningham, F.G.S., Liverpool.
M. Achille Delesse, Paris.
Sir Walter Elliot, K.S:I., F.L.S., President Botanical Society, Edinburgh, Wolfe Lee, Hawick.
Rev. Thomas England, F.G.S., &c., North Lew, Devon.
William Henry Flower, F.R.S., F.L.S., F.G.S., Conservator Hunterian Museum, London.
Abraham Gesner, M.D., F.G.S., &c., New York.
Sir R. J. Griffith, Bart., LL.D., F.R.S., F.G.S., &c., Dublin.
Mr. Thomas Hawkins, F.G.S, Whitwell, Isle of Wight.
Mr. Sydney Hodges, Torquay.
Mr. Robert Hunt, F.R.S , F.S.S., &c., London.
Mr. John Edward Lee, F.A.S., F.G.S., Caerleon, Monmouth.
Sir Charles Lyell, Bart., D.C.L., LL.D., F.R.S., F.L.S., F.G.S., London.
Mr. Henry McLauchlan, F.G.S., London.
M. Leon Moissenet, Paris.
T. Oldham, LL.D., F.R.S., F.G.S., Calcutta.
Richard Owen, M.D., D.C.L., F.R.S., F.L S., F.G.S., British Museum, London.
Mr. Joseph Parker, F.G.S., Upton Cheyney, Gloucestershire.
Mr. Charles W. Peach, A.L.S., &c., Edinburgh.
Mr. William Pengelly, F.R.S., F.G.S., Torquay.
John Phillips, LL.D., F.R.S., F.G.S , Oxford.

Lyon Playfair, C B., M.P., Ph.D., F.R.S., &c., Edinburgh and London.
Mr. Frederick Anthony Potter, F.G.S., Derby and London.
Mr. Joseph Prestwich, F.R.S., F.G.S., &c., London.
M. Constant Prévost, Paris.
Mr. Martyn J. Roberts, F.R S., Crickhowell, Brecknockshire.
Rev. A. Sedgwick, M.A., LL.D., F.R S., F.L.S., F.G.S., Woodwardian Professor of Geology in the University of Cambridge.
Professor Schœnbein, Basle.
Mr. James Tennant, F.G.S., Professor of Geology, King's College, London.
Major-General G. B. Tremenheere, R.E., late H.M. Bengal Army, F.G.S., London.
Major-General Charles Tremenheere, R.E., C.B., H. M. Bombay Army.
Mr. W. Wagner, President Wagner Institute, &c., Philadelphia, U.S.
Mr. Nicholas Whitley, Truro.

Life Members.

Mr. T. Adair Masey, F.G.S., London.
Mr. Warington W. Smyth, F.R.S., F.G.S., &c., London.

Ordinary Members.

Mr. G. L. Basset
,, J. H. Batten, F.R.G.S.
,, G. Bettany
,, Henry Blackwell
,, Francis Boase
,, Edward Bolitho
,, T. S. Bolitho
,, William Bolitho
,, R. F. Bolitho
,, T. Bedford Bolitho
,, T. Robins Bolitho
,, William Bolitho, jun
,, John Borlase
,, Walter Borlase
,, William C. Borlase, F.S.A.
,, Richard Boyns
,, J. R. Branwell
,, F. W. Brittain
Miss E. T. Carne
Mr. Thomas Cornish
,, J. Claude Daubuz
,, Richard Davey, F.G.S.
,, Joshua Sydney Davey
,, Edward G. Davenport
,, James Dennis
,, John Dennis
,, William Dennis
,, N. B. Downing
,, S. T. G. Downing
Viscount Falmouth
Mr. Clement Le Neve Foster, B.A., D.Sc., F.G.S.
,, Robert Were Fox, F.R.S.
,, Charles Fox
,, Robert Fox
,, Alfred Lloyd Fox
,, Alfred Fox
,, Charles F. Giesler
,, Henry Grylls
Mrs. Richard Harvey
Mr. C. H. T. Hawkins
Rev. Prebendary Hedgeland, M.A.
Mr. W. J. Henwood, F.R.S.
,, Samuel Higgs
,, Samuel Higgs, jun., F.G.S.
,, Stephen Hill
,, William Husband
,, Stephen Harvey James
,, J. J. Lanyon
,, Edward Lavin
,, Day P. Le Grice, M.A.
,, Martin Magor
Rev. J. H. Marshall
Mr. A. H. Michell
,, J. P. Milton
,, William Mitchell
Earl of Mount Edgcumbe
Mr. S. R. Pattison, F.G.S.
,, H. Paull
,, R. Pearce, F.G.S.

Rev. M. N. Peters, M.A.
Mr. J. T. H. Peter
,, T. Roxburgh Polwhele, M.A., F.G.S.
,, E. Hearle Rodd
,, W. H. Rodd
,, J. Jope Rogers
,, John Roscorla
,, C. Campbell Ross
Sir Edward St. Aubyn, Bart.
Mr. John St. Aubyn, M.P.
Rev. Edmund St. Aubyn
Earl of St. Germans, G.C.B.
Sir Edward Smirke
Mr. Bickford Smith
Rev. F. Stephens
Mr. John Symons
,, Richard Taylor, F.G.S.
Mr. William Teague
,, J. Vosper Thomas
Rev. J. Tonkin
Colonel A. Tremayne
Mr. H. S. Tremenheere, C.B., M.A., F.G.S.
Col. H. R. Trelawny
Mr. William Trythall
,, Robert Tweedy
,, A. P. Vivian, M.P.
Sir Richard R. Vyvyan, Bart., F.R.S., F.G.S.
Mr. William West, C.E.
Sir Frederick M. Williams, Bart., M.P., F.G.S.
Mr. J. Michael Williams
,, George Williams

Associates.

Mr. Arundel Anthony, Lelant
,, Richard Bain, Burncoose
,, Francis Barratt, St. Austell
,, James Bennetts, St. Just
,, Thomas Blamey, Gwennap
,, J. T. Blight, F.S.A., Penzance
,, Charles Chorley, Truro
,, J. H. Collins, F.G.S., Falmouth
,, William Eddy, Pendeen Consols Mine, St. Just
,, James Evans, Illogan
,, John Giles, Sheffield
,, William Gregor, Swansea
,, R. T. Hall, (Devoran), Africa
,, William Hollow, Lelant
,, W. F. Hooper, Truro
,, Richard James, St. Ives
Mr. S. Michell, Swansea
,, John Nancarrow, Camborne
,, Richard Newton, St. Agnes
,, Francis Oats, St. Just
,, Henry Pascoe, Berehaven Mines, Co. Cork
,, John Phillips, Australia
,, W. Provis, Dolcoath
,, John Rowe, Botallack, St. Just
,, Stephen Thomas, Redruth
,, Thos. Treloar, (Brazil), London
,, Thomas Trezise, Redruth
,, Thomas Treweeke, St. Ives
,, Joseph Vivian, Camborne
,, William Vivian, Mwyndy, Glamorganshire
,, John Way, Gwennap

QE
262
C8a
A2

TRANSACTIONS

OF THE

Royal Geological Society

OF

CORNWALL.

INSTITUTED FEBRUARY 11th, 1814.

VOLUME THE NINTH.

"A knowledge of our subterranean wealth would be the means of furnishing greater opulence to the country than the acquisition of the mines of Mexico and Peru."

President of the Board of Agriculture.

PENZANCE:
SOLD AT THE APARTMENTS OF THE SOCIETY.
1878.

CONTENTS.

ANNUAL REPORTS.

FIFTY-FIRST ANNUAL REPORT— PAGE

Address of the President, Mr. Charles Fox, on laying the foundation-stone of the New Buildings, 28th April, 1864.

Officers and Council for 1864.

Address of the President, Mr. Charles Fox, at the Annual Meeting.

Haughton on the Granites of Donegal 6

Sterry Hunt and Zirkel on Crystalline Rocks . . 7

Stratigraphy of Cornwall 8

Geological Time 13

The Evolution Hypothesis 14

Report of the Council 17

Donations to the Museum and Library 21

Treasurer's Account 22

FIFTY-SECOND ANNUAL REPORT—

Officers and Council for the year 1864.

Address of the President, Mr. Charles Fox, at the Annual Meeting.

Organic Remains of the Laurentians 6

Petroleum-bearing Strata 9

Temperature of the Earth 11

Californian Gold Reefs 12

Kent's Cavern 14

Report of the Council 18

Donations to the Museum and Library 22

Treasurer's Account 23

FIFTY-THIRD ANNUAL REPORT—

Officers and Council for 1865.

Address of the President, Mr. Charles Fox, at the Annual Meeting.

PAGE

Eozoon Canadense 6
The Geology of Norway 7
Devonian Rocks of North Devon 8
Formation of Valleys 9
Coal-fields Commission 11
Miocene Flora of Greenland 13
The Development Theory 14
Report of the Council 19
Curator's Report 23
Treasurer's Account 25

FIFTY-FOURTH ANNUAL REPORT—
Address of the President, Mr. Charles Fox.
The Cornish Fossils 9
Nature of Granite 12
Igneous Rocks 15
Nature of Serpentine 16
Meteors and Meteor-showers 19
Cavern Explorations 21
Report of the Council 23
Curator's Report 26
Librarian's Report 27
Treasurer's Account 28
Officers and Council for 1867-8.
List of Members.

FIFTY-FIFTH ANNUAL REPORT—
Officers and Council for 1868-9.
Address of the President, Mr. Hugh Seymour Tremenheere, M.A., F.G.S.
Outline of the History of the Society 6
The Fossil Collections 7
Appointment of Building Committee 8
The New Laboratory and Class-rooms 11
Chemical Treatment of Cornish Ores 14
Value of a Mineralogical Museum 17
Geological Time 19
Cornish Geological Problems 21
Obituary Notices of Sir Charles Lemon, Dr. Davy, and the Rev. W. Veale 22
Report of the Council, 1868 25
Librarian's Report 30
Curator's Report 33
Treasurer's Account 35
List of Members, 1868–9 37

FIFTY-SIXTH ANNUAL REPORT— PAGE

Officers and Council for 1868–9.
Address of the President, Mr. H. S. Tremenheere, F.G.S.
The Fossil Collections 7
The New Buildings 8
The Proposed Laboratory 11
Scientific Instruction 14
Mr. Henwood's Labours 15
Revision of Rules 20
Report of the Council 22
Librarian's Report 26
Curator's Report 28
Treasurer's Statement 32
List of Papers read at Annual Meeting.

FIFTY-SEVENTH ANNUAL REPORT—

Officers and Council for 1869–70.
Address of the President, Mr. H. S. Tremenheere, F.G.S.
The Museum 6
Mr. Henwood's Labours 7
Subterranean Temperature 9
Mr. Peach's Discoveries in Cornish Palæontology . . 11
The Tennasserim Tin Deposits 13
Diamonds of South Africa 15
Obituary—Sir William Williams 17
Mr. Jonathan Couch 18
Major Bickford, Mr. R. Harvey, Mr. L. Vigurs 19
Report of the Council, 1870 20
Librarian's Report 25
Curator's Report 28
Treasurer's Statement 30
List of Papers read at Annual Meeting.

FIFTY-EIGHTH ANNUAL REPORT—

Officers and Council for 1870–71.
Address of the President, Mr. H. S. Tremenheere, F.G.S.
Mr. Henwood's Labours 5
Scientific Instruction 7
Geological Problems 11
Obituary—Sir Thomas Acland, Bart. 18
Mr. William Hustler, Sir R. I. Murchison . 19
Report of the Council 22
Librarian's Report 25
Curator's Report 28

PAGE
Treasurer's Statement 33
List of Papers read at Annual Meeting.
Officers and Council for 1871–72.
List of Members.

FIFTY-NINTH ANNUAL REPORT—
Officers and Council for 1872–73.
Address of the President, Mr. W. W. Smyth, F.R.S.
Obituary Notices of Messrs. Augustus Smith, John S. Enys, C. D. Bevan, C. W. Boase, William Lonsdale 8–10
Vol. VIII. of the *Transactions*, and its Author, Mr. W. J. Henwood 11
Importance of Mining Data 11
The Granites, Elvans, and Greenstones 12
The Position and Relations of the Sedimentary Rocks of Cornwall 12
Changes of Level on the Cornish Coasts 13
Report of the Council 16
Librarian's Report 20
Curator's Report 23
Balance-sheet, 1871–2 24
List of Papers read at the Annual Meeting 25

SIXTIETH ANNUAL REPORT—
Officers and Council for 1873–4.
Address of the President, Mr. W. W. Smyth, F.R.S.
Obituary Notice of Miss Carne 32
" Professor Sedgwick 33
" Mr. J. T. H. Peter 34
" Sir Edward St. Aubyn 35
The Fossil Collections 35
Connection of Geology with Mining 36
Deep Mines of Przibram 38
Discovery of Tin in Queensland 39
Tin Deposits of Tennasserim 40
Curator's Report 41
Treasurer's Account, 1872–3.
List of Papers read at the Annual Meeting.
List of Members, 1873.

SIXTY-FIRST ANNUAL REPORT—
Officers and Council for 1874–5.
Address of the President, Mr. W. W. Smyth, F.R.S.

PAGE

Obituary—Professor John Phillips . . . v.
M. Elie de Beaumont . . . . vi.
Mr. Henwood's Works . . . . . ix.
M. Moissenet on the Lodes of Cornwall . . ix.
Elie de Beaumont's Theories . . . . xiv.
Report of the Council . . . . .
Librarian's Report . . . . . xviii.
Curator's Report . . . . . xxi.
Assistant Curator's Report . . . . . xxiv.
Treasurer's Statement, 1877–74.
List of Papers read at Annual Meeting.
List of Members.

SIXTY-SECOND ANNUAL REPORT—
List of Officers, 1875–6 . . . . . iii.
List of Members . . . . . iv.
Address of the President, Mr. W. W. Smyth, F.R.S. . x.
Obituary Notice of Mr. W. Jory Henwood . . x.
" Sir Charles Lyell . . xiii.
" Sir Edward Smirke . . xviii.
" Messrs. R. Paynter, J. Symons, and E. Davenport, M.P. . xviii.
Mr. Barnett's Classes . . . . . xix.
Sub-Wealden Boring in Sussex . . . . xx.
Deep Mines in Bohemia . . . . . xxi.
Report of the Council . . . . . xxiii.
Librarian's Report . . . . . xxviii.
Curator's Report . . . . . xxxii.
Treasurer's Statement, 1874–5.
List of Papers read at the Annual Meeting.

SIXTY-THIRD ANNUAL REPORT—
Officers and Council for 1876–7.
List of Members.
Address of the President, Mr. W. W. Smyth, F.R.S.
Obituary Notices . . . . . xi.
Local Geology . . . . . xii.
J. W. Judd on Geology of Granite, &c. . . xiii.
Bischoff's Chemico-mineralogical Researches . xvi.
Daubrée on Minerals of Bourbonne-les-Bains . xvi.
Report of the Council . . . . . xxi.
Librarian's Report . . . . . xxv.
Curator's Report . . . . . xxvii.
Treasurer's Statement, 1875–6.
List of Papers read at the Annual Meeting.

SIXTY-FOURTH ANNUAL REPORT— PAGE

Officers and Council for 1877–8.
List of Members.
Address of the President, Mr. W. W. Smyth, F.R.S. . xi.
Obituary Notice of Mr. R. W. Fox, F.R.S. . . xi.
" The Earl of St. Germans, Dr. Bryce, and Mr. D. Forbes . xv.
The Fossil Collections . . . . xvi.
The Fossils of Cornwall . . . . xvii.
The Geology of Cornwall . . . xviii.
Mr. Juke's Views thereon . . . xx.
Dr. Holl on the Cornish Rocks . . . xxiv.
Table of British and Foreign Devonian Fossils . xxvi.
Report of the Council . . . . xxvii.
Librarian's Report . . . . xxix.
Curator's Report . . . . xxxii.
Mr. Etheridge on the Collection of Fossils . . xxxiii.
List of Papers read at the Annual Meeting . . xxxv.
Treasurer's Statement, 1876–7.

TRANSACTIONS.

PAGE

On Transition and Metamorphosis of Rocks in the Land's End District. By Miss Elizabeth T. Carne . . . 1

A Contribution to the Theory of Mineral Veins. By Robert Hunt, F.R.S. 22

On Tooth and Fragments of Bones of Hippopotamus, from the neighbourhood of Constantine, in Algeria. By Charles Fox . 26

On the Fossil Fish of Cornwall. By Charles W. Peach, A.L.S. . 31

Notice of an Accumulation of Carburetted Hydrogen, or "Fire Damp," in the Ding Dong Mine, situated in the parish of Madron, near Penzance. By Samuel Higgs, jun., F.G.S., &c. 34

On the Occurrence of Metallic Ores with Garnet Rock. Note illustrating a series of Copper Ores from Belstone Consols, Devon. By Warington W. Smith, M.A., F.R.S., F.G.S. . . 38

On some Fossils from Mount Lebanon. By Alfred Lloyd Fox. . 46

Remarks (with a list) on some of the Organic Remains of Cornwall in the Museum of the Royal Geological Society of Cornwall at Penzance. By C. W. Peach 49

On the discovery of Organic Remains in the Rocks of Nelly's Cove, near Porthalla, and of some curious Organic-like Masses in a quarry near Hayle. By C. W. Peach . . . 55

Some Observations on the Magnesite of Silesia. By Lovell Squire, jun., B.A. 59

The Geology of Lundy Island, with Map. By Nicholas Whitley. 71

Remarkable Sea Waves, observed in Mount's Bay, Cornwall, April 24th, 1868. By John Jope Rogers 74

Notes on the Quartz Rèefs or Lodes of Sandhurst, Victoria, Australia. By W. Nicholas 78

Memorandum on the Discovery of Hazel-nuts in Tin Stream at St. Hilary. By Thomas Cornish 98

Note on Chrome Iron in the Serpentine of the Lizard. By Richard Pearce, F.G.S. 99

Note on a Granite Block at Halamanning. By Richard James . 101

Memorandum on Pitchblende in Colorado. By Richard Pearce . 102

Note on Pitchblende in Cornwall. By Richard Pearce . . 103

PAGE

On Traces of Glacial Action on the Great Cairn, near Gorran Haven, Cornwall. By C. W. Peach 105

The Geology of Penzance Bay and its Shores, with Map. By Nicholas Whitley 109

On the Bones of a Whale found at Pentuan, now in the Museum of the Royal Geological Society of Cornwall. By William Henry Flower, F.R.S., &c. 114

Some Remarks on the Mining District of Yorke's Peninsula, South Australia. By Samuel Higgs, jun. 122

Enquiry into the Nature of the Forces that have acted on the Formation and Elevation of the Land's End Granite. By Miss Elizabeth T. Carne 132

Remarks on the Lode at Wheal Mary Ann, Menheniot, with Diagrams. By Clement Le Neve Foster, B.A., D.Sc., F.G.S. . 152

Notice of a "Vugh" in St. Ives Consols Mines. By Captain John Gilbert 158

Notice on Mount Bischoff, Tasmania. By William Wellington . 161

On the Place and Mode of Occurrence of the Mineral Andrewsite. By C. Le Neve Foster, B.A., D.Sc., F.G.S. 163

A Diamond Field, West Griqualand, South Africa. By Charles Fox 165

Remarks upon the Tin Deposits of East Wheal Lovell. By C. Le Neve Foster, B.A., D.Sc., F.G.S. 167

On a Deposit of Quartz Gravel at Blue Pool, in Crowan. By W. Tyack. (Communicated by Dr. C. Le Neve Foster) . . 177

Notes on some Fossils found at Bude. By W. Linford . . 183

On Mineral Lodes (*abstract*). By James Williams . . . 184

On the Occurrence of Tin in an Elvan Course at Wheal Jennings. By George Seymour, jun., Assoc. R.S.M. 185

On some Beds of Sand and Clay in the parish of St. Agnes, Cornwall. By Alfred T. Davies and Benedict Kitto, F.G.S. . . 196

Remarks on some Tin Lodes in the St. Agnes District. By C. Le Neve Foster, B.A., D.Sc., F.G.S. 205

On the Trelissick Elvan, with a proposed Classification of the Cornish Elvans. By J. H. Collins, F.G.S. 221

A New Tin Scheme; or, Notes on Manufactured Articles of Pure Tin. By W. Copeland Borlase, F.S.A. 229

LIST OF PLATES.

		PAGE
Geological Map of Lundy Island . .	*to face*	72
Geological Map of the Shores of Penzance Bay .	„	109
Sketch-plan of East Wheal Lovell at the 40-fathom level (Pl. I.)	„	168
Sections, &c., at East Wheal Lovell (Pl. II.) .	„	170
Section at the 80-fathom level, ditto (Pl. III.) .	„	170
Diagram of Movements of the Ground, ditto (Pl. IV.)	„	172
Strings of Tin Ore at Wheal Jennings (Pl. I.) . .	„	188
„ „ „ (Pl. II.) .	„	190
Diagrams of Dislocations, ditto (Pl. III.) .	„	192
Map of the Sand and Clay Beds at St. Agnes (Pl. IV.)	„	196
Section of the Clay Beds at St. Agnes (Pl. V.) .	„	200
Sections of the Lode at Penhalls Mine (Pl. VI.) .	„	206
Sections of the Lode at Wheal Kitty (Pl. VII.) .	„	210
Sections of the Tin Deposits at Wheal Coates (Pl. VIII.)	„	212
Sections of Tin-bearing Veins at Cligga Head (Pl. IX.)	„	216
„ „ „ showing heaves (Pl. X.)	„	216
Section showing Junction of Granite and Slate at Cligga Head (Pl. XI.) . . .	„	218
Sketches showing the Microscopic Structure of some Cornish Elvans	„	225

INDEX.

PAGE

A Diamond Field, West Griqualand 165
A New Tin Scheme 229
Algeria, Fossils from 26
„ Geology of 27
Amorphozoa of Cornish Rocks 51
Andrewsite, C. Le Neve Foster on 163
„ Composition 164
Annelida of Cornish Rocks 52

Baumgarten, Magnesite of 61
Beds of Sand, &c., at St. Agnes 196
Belstone Consols, Garnet Rock of 39
„ „ Ores of 39
Bendigo Gold Field 81
Blue Pool, Quartz Gravel of 177
Bones of Whale from Pentewan 114
BORLASE, W. C., on a New Tin Scheme 228
Brachiopoda of Cornish Rocks 52
"Branches" at Wheal Jennings 188
Bude, Fossils from 182
"Bunches" at East Wheal Lovell 170

Cadgwith, Chromite from 100
California, Mineral Veins of 23
Candle Clay of St. Agnes 197
Capels at Penhalls Mine 207
„ at Wheal Kitty 209
Carburetted Hydrogen at Ding Dong 34
CARNE, Miss E., on the Land's End Granite . . 1, 132
„ „ on Rock Transitions 1
Cephalopoda of Cornish Rocks 53
Chalcosiderite, Composition of 164
"Chimneys" at East Wheal Lovell 170

PAGE
Chrome Iron Ore of Cadgwith 99
Classification of Cornish Elvans 225
Cligga, C. Le Neve Foster on 213
„ Greisen of 216
„ Junction at 217
Climate of Yorke's Peninsula 124
Cœlenterata of Cornish Rocks 51
COLLINS, J. H., on the Cornish Elvans 221
Colorado, Pitchblende from 102
CORNISH, T., on Fossil Fruits from Tregilso 98
Cornish Fossils . . 31, 49, 51, 57, 98, 114, 182
„ Rocks 1, 55, 99, 101, 105, 109, 132, 152, 167, 177, 185, 196, 205, 221
Cornwall, Fossil Fishes of 31
„ Glacial Action in 105
„ Organic Remains of . 31, 49, 51, 57, 98, 114, 182
„ Pitchblende of 103
Cradle, Use of in Cornish Mining 215
Crousa Downs, Quartz Gravel of 177
Crustacea of Cornish Rocks 52

DAVIES, A. T., on the St. Agnes Sands, &c. 196
Ding Dong Mine, Gases at 34
Dolcoath, Pitchblende from 103
Drift of Mount's Bay 111
„ Wheal Darlington 112

East Wheal Lovell, Tin Deposits of 166
„ „ Statistics of 176
Echinodermata of Cornish Rocks 52
Elevation of the Land's End Granite 132
Elvans, Analyses of 227
„ at Trelissick 221
„ Classification of 225
„ Different types of 225
„ J. H. Collins on 221
„ Tin in, at Wheal Jennings 185
Eophyton (?) from Hayle 57
Eschrichtius robustus 114, 117

Fire Clay of St. Agnes 197
FLOWER, W. H., on *Eschrichtius robustus* 114
Formation of Land's End Granite 132
„ Lode at Wheal Mary Ann 155
„ Tin Deposits at East Wheal Lovell 171
Fossil Fish of Cornwall 31

PAGE
Fossils from Bendigo Gold Field 81
„ Bude 182
„ Mount Lebanon 46
„ Nelly's Cove 55
„ Tregilso Stream Works 98
FOSTER, C. Le Neve, on Andrewsite 163
„ „ Cligga 213
„ „ East Wheal Lovell 166
„ „ Penhalls Mine 206
„ „ Tin Lodes at St. Agnes 205
„ „ Wheal Coates 211
„ „ „ Kitty 209
„ „ „ Mary Ann 152
FOX, Charles, on a Diamond Field 165
„ „ Fossils from Algeria 26
„ „ Fossils from Lebanon 46
Frankenburg, Magnesite of 61
Frankenstein, Magnesite of 61

Garnet, Occurrence of, in Cornwall 38
„ Rock at Belstone Consols 39
Gas, Accumulation of, at Ding Dong 35
Gasteropoda of Cornish Rocks 53
Geology of Algeria 27
„ Lundy Island 71
„ Mount's Bay 109
GILBERT, J., on a "Vugh" at St. Ives Consols 158
Glacial Action in Cornwall 105
Gorran, Glacial Action at 105
Granite, Analyses of 227
„ Block from Halamanning 101
„ of East Wheal Lovell 169
„ of Land's End District 1, 132
„ Tabular Structure of 147
Great Cairn, Glacial Action at 105
Greisen at Cligga 216

Halamanning, Granite Block from 101
Hayle, *Eophyton* (?) from 57
Hazel Nuts from Tregilso 98
HIGGS, S., jun., on Gases at Ding Dong 34
„ „ the Wallaroo District 127
„ „ Yorke's Peninsula 122
Hippopotamus Teeth, &c. 26
Hornblende Rocks of Land's End District 1

PAGE
Hornblende Rocks of Mount's Bay 109
HUNT, R., on Mineral Veins 22

JAMES, Richard, on Granite from Halamanning 101

KITTO, B., on Sands, &c., of St. Agnes 196

Lamellibranchiata of Cornish Rocks 53
Land's End District 1
" " Granite 132
" " " Structure of 134
"Leaders" at East Wheal Lovell 170
" Penhalls Mine 207
" Wheal Kitty 209
Lelant Rocks 3
LINFORD, William, on Fossils from Bude 182
Lizard, Chrome Iron from the 99
Lode at Wheal Mary Ann 152
" Penhalls 207
" Wheal Kitty 209
Lodes, Formation of 155, 170
Lundy Island, Geology of 71

Magnesite Works of Silesia 59
Mineral Veins, Hunt on Theory of 22
" " of California 23
" " of St. Agnes 205
" " Williams on 183
Minerals at Penhalls Mine 207
Mining District of Yorke's Peninsula 122
Mount Bischoff, Tin Deposits of 161
Mount Lebanon, Fossils from 46
Mount's Bay, Drift Beds of 111
" " Remarkable Waves in 74

Nelly's Cove, Fossils at 55
Newlyn, Felspathic Rocks of 2
NICHOLAS, W., on Quartz Reefs of Sandhurst 78
Nucleobranchiata of Cornish Rocks 53
Nuts from Tregilso Stream Works 98

Organic Remains of Cornwall 51
" " Nelly's Cove 55

PEACH, C. W., on Cornish Fossil Fish 31
" " *Eophyton* (?) from Hayle 57

PAGE
PEACH, C. W., on Glacial Action in Cornwall . . . 105
" " Organic Remains of Cornwall . . . 49
" " " " Nelly's Cove . . . 55
" " *Steganodictyum* 31
PEARCE, Richard, on Chrome Iron Ore 99
" " Pitchblende from Colorado . . . 102
" " " " Cornwall . . . 103
Pebble-bed at Blue Pool 178
" " Crousa Down 181
Penhalls Mine, C. Le Neve Foster on 206
Pentewan, Fossil Whale from 114
Penzance Bay, Geology of 109
Peraver, Glacial Action at 105
"Pipes" at East Wheal Lovell 169
Pisces of Cornish Rocks 54
Pitchblende from Colorado 102
" in Cornwall 103
Plantæ of Cornish Rocks 51
Polyzoa of Cornish Rocks 52
Pteropoda of Cornish Rocks 53
Purple Killas of Newlyn 2
Pyrites of Bendigo Gold Field 82

Quartz Gravel of Blue Pool 177
" " Crousa Downs 181
" Reefs of Sandhurst, Victoria 78

Remarkable Sea Waves 74
Rocks, Crystallization of 15
" Dip of, in West Cornwall 139
" of Gurnard's Head 9
" " Lelant 3, 6
" " Land's End District 1
" " Mousehole 7
" " Newlyn 2, 7
" Transitions of 1, 5
ROGERS, J. J., on Remarkable Sea Waves 74

Sandhurst, Victoria, Quartz Reefs at 78
Sands and Clays of St. Agnes 198
Saint Austell Consols, Pitchblende from 103
" Agnes, Sands and Clays at 196
" " Tin Lodes at 205
" Hilary, Fossil Nuts from 98
" Ives Consols, "Vugh" at 158

PAGE
Saint Just, Pitchblende from 104
Sea Waves, Remarkable 74
Serpentine, Chromite from 99
SEYMOUR, George, jun., on Wheal Jennings . . . 185
Silesia, Magnesite from 59
SMYTH, W. W., on Belstone Consols 39
South Tresavean, Pitchblende from 103
SQUIRE, Lovell, jun., on Magnesite 59
Statistics of East Wheal Lovell 176
Stockworks 174, 213
Strata at Tregilso Stream Works 98
"Strings" and "Branches" at Wheal Jennings . . . 188
Structure of Cornwall and Devon 145
" Land's End Granite 134

Tasmania, Tin Deposits of 161
Tin-bearing Elvan at Wheal Jennings 185
Tin Deposits of East Wheal Lovell 166
" Dinner-service 233
" Lodes in the St. Agnes District 205
" Ornaments 230
Transitions of Rocks 1, 5
Tregilso Stream Works 98
Trelissick, Elvan at 221
TYACK, William, on Quartz Gravel at Blue Pool . . . 177

Valleys of the Land's End District 139
Victoria Point, Elvan at 223
" Quartz Reefs of 78

Wallaroo, Mining District of 127
WELLINGTON, William, on Mount Bischoff . . . 161
West Griqualand, Charles Fox on 165
West Phœnix, Andrewsite from 163
Whale Bones from Pentewan 114
Wheal Coates, Stockwork at 211
" Jennings, Tin in Elvan at 185
" Kitty, Lode at 209
" Mary Ann, Lode at 152
" Owles, Pitchblende from 104
WHITLEY, N., on Geology of Mount's Bay . . . 109
" " Lundy Island 71
WILLIAMS, James, on Mineral Lodes 183

Yorke's Peninsula, Mining District of 122

ERRATA.

Page vi., line 23, for "*u*" read "*a*" in Hulamanning.
Page 3, line 25, for "*on*" read "*or*."
Page 17, line 5, for "*oride*" read "*oxide of tin*."
Page 25, line 21, for "*Crystallyanic*" read "*Crystallogenic*."
Page 38, line 5, for "*Smith*" read "*Smyth*."
Page 42, line 7, for "*ruggy*" read "*vuggy*."
Page 47, line 5, for "*—nagian*" read "*—magian*."
Page 53, line 5 & 7, for "*Ethridge*" read "*Etheridge*."
Page 54, line 11, *ditto.* *ditto.*
Page 59, line 11, for "*its*" read "*it*."
Page 60, line 2, for "*Kranbat*" read "*Kraubat*."
Page 60, line 2, for "*Strub*" read "*Hrub*."
Page 63, line 5 from below, for "*dampfrnehl*" read "*Dampfmehl*."

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

FIFTY-NINTH, AND SIXTIETH

ANNUAL REPORTS

OF THE COUNCIL,

WITH THE

PRESIDENT'S ADDRESS, TREASURER'S AND LIBRARIAN'S REPORTS,

&c., &c.

PENZANCE:
F. RODDA, GENERAL MACHINE PRINTER, &c., 6, MARKET PLACE.

1874.

QE
262
.C8
A2

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

ERRATA.

Page 7, last line, for "*rearly*" read "*rarely.*"

Page 13, line 16, for "*Balænidæ*" read "*Balænidæ.*"

Page 36, line 6, for "*qurassic*" read "*jurassic.*"

Page 37, line 26, for "*lest*" read "*least.*"

Page 42, line 17, for "*Cornubic*" read "*Cornubiæ.*"

PENZANCE.

1872.

QE
262
.C8
A2

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

FIFTY-NINTH

ANNUAL REPORT.

PENZANCE.

1872.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

Her Most Gracious Majesty The QUEEN.

Vice-Patron:

His Royal Highness the Prince of Wales, K.G., &c., &c.

Trustees:

Thomas S. Bolitho, Esq.
John S. Enys, Esq., F.G.S.
Day P. Le Grice, Esq., M.A.

OFFICERS AND COUNCIL FOR 1872-73.

President:

Warington W. Smyth, Esq., F.R.S., F.G.S.

Vice-Presidents:

Hugh Seymour Tremenheere, Esq., C.B., F.G.S.
John St. Aubyn, Esq., M.P.
D. P. Le Grice, Esq., M.A.
A. P. Vivian, Esq., M.P.

Treasurer:

William Bolitho, Jun., Esq.

Secretary:

John Hallet Batten, Esq., F.R.G.S., M.R.A.S.

Librarians:

Edward Hearle Rodd, Esq.
Charles Campbell Ross, Esq.

Curators:

George B. Millett, Esq.
G. T. Bettany, Esq.

Council:

The Officers of the Society

T. B. Bolitho, Esq.
T. Cornish, Esq.
John Dennis, Esq.
Robert Fox, Esq.
Rev. Preb. Hedgeland.
W. Husband, Esq.
John Roscorla, Esq.
W. Bickford Smith, Esq.
Lieut. Col. Trelawny.
Col. Tremayne.
R. Tweedy, Esq.
J. M. Williams, Esq.

PRESIDENT'S ADDRESS.

In opening the proceedings of your Annual Meeting, I am unable to avoid what may bear the semblance of egotism, yet is forced upon me by the very fact of your having voted me into the honourable position from which I now address you. Such a mark of your good-will and confidence was entirely unexpected by me, and when the proposition was first made, I recoiled from entertaining it, desirous, as I was, that the Presidency should be entrusted, as it so successfully has been in days of yore, to some one of the active Members of the Society dwelling constantly in your midst; and I confess to having been not altogether unaffected by the selfish impression that I had, already, in my ordinary avocations, more than enough of work. But the warmly expressed feeling of your Council left me no alternative: I bow to the admirable spirit of the county motto, "One and All," and holding, that every man is bound to add his mite to the store of general good, shall be amply satisfied if, through my connexion with other centres of analogous studies, I may be able to aid the progress of a Society which has already achieved so much in the cultivation of geological science.

Looking back on the galaxy of eminent men, who have adorned your annals, and, either in the chair or the Council, or in the pages of your *Transactions*, have advocated and promoted your interests, I cannot but feel that we, of the present time, have a noble but a serious task set before us, to maintain worthily the character of the Institution which has been handed down to us. In the nature of mundane things, most of the founders and office-bearers of the first portion of your history have passed away, and it is only rearly that, as in some instances which with sincere pleasure we

hail amongst us this day, we can hope to see the "*mens sana in corpore sano*" prevail over the weight of fourscore years, and prompt the undertaking of a tedious journey, in order to testify to the interest still taken by our veteran friends in pursuits which form the solace of old age, as they have been the business or the recreation of earlier years.

And the tinge of sadness that colours our remembrance of the good men and true who have been removed from among us is renewed when we look to the losses which the Society has sustained during the past year.

Who that was acquainted with the vigorous mind and stalwart frame of Mr. Augustus Smith could have anticipated—but a few short months ago,—that his thread of life was so nearly severed! Who that had the pleasure of his friendship but expected hopefully again to discuss with him, in that little empire of the Scilly Islands which he loved so well, the strange forms of the granite rocks, and the origin of the chalk flints, which he described to you in 1858 in the paper printed in Vol. VII of the *Transactions*?

It is true that for some time past Mr. Smith had found his health impaired, and that on several occasions his friends had been alarmed by threatening symptoms; yet his cheerfulness and energetic interest in all around him seemed to continue unabated. It will be fresh in the recollection of the Society that the "lord proprietor" of Scilly, whose connection with Cornwall began in 1834, occupied your presidential chair for several years, having been elected on the resignation of Sir Charles Lemon in 1857, and holding office till 1864. And I cannot refrain from noticing the earnest spirit in which, at the anniversary meetings, he brought forward his views, no less on science than on the social aspects of your Institution It is scarcely needful to refer to the gallant fight which he made against the seductive "Vestiges of Creation" at one time, and against Darwin's more successful hypotheses at another; nor to remind you of the careful and sympathetic biography of deceased members which he was wont to compile; but his references to the early history of the Society, and his stirring call upon the rising

generation of Cornish gentry, to emulate the intellectual activity of their fathers are couched in a vein which often rises to eloquence, and deserve to be read and read again.

A lengthy portion of several of his addresses is occupied by questions of high importance to your welfare, which, fortunately, after a somewhat stormy period of uncertainty and differences of opinion, have been set at rest.* Thus the transference of the Society's property into our present handsome apartments, and our incorporation in the general edifice of the "Public Buildings," are "accomplished facts" which invite no hostile criticism. We have in these walls nothing to say to Mr. Smith's labours of duty as a Member of Parliament, or of charity as a Freemason, but must recognize that his education begun at Harrow, completed at Christchurch, and matured by his after studies—rendered him a many-sided man, an appreciative reader of standard works, of which in Tresco he possessed a fine library, and a lover of numerous branches of natural science. Mr. Smith was born in Herts in 1801, and died at Plymouth in July last.

In Mr. John Samuel Enys, of Enys, the Society has lost an old member, who served for many years as councillor, vice-president, and as one of the trustees. Born in 1796, and educated at Winchester and Exeter College, Oxford, Mr. Enys, in taking up his residence in Cornwall, early devoted his attention to the theory and working of the Cornish engine and boiler. His father-in-law, Mr. Davies Gilbert, President of our Society and of the Royal Society, no doubt did much to confirm Mr. Enys's love of physical science; and his taste for geology was greatly brought out by the companionship of Sir Henry De la Beche, when that talented and indefatigable geologist was engaged on the survey of the county, It was especially with the physical structure of the granites, elvans, and killas that Mr. Enys occupied himself: he collected a mass of details as to joints and other external characters, which, had he possessed the graphic pen-power of a Ruskin, when discoursing on

* See Mr. Smith's address for 1858 and 1859.

the same subjects,* would have left a mark in the geological, if not in the artistic world. But Mr. Enys never did justice to himself; he contributed papers on the "duty" of steam engines to the British Association in 1836 and 1841, to the Official Report in Cornwall and Devon by De la Beche, 1839, and to the Institution of Civil Engineers of which body he was an associate; yet the many facts collected in connexion with geology, and the quaint analogies and illustrations which he was want to use in conversation, were never published in a well-revised or generally readable form. Mr. Enys had been sinking for some years past, and died at his own seat, the 29th May, 1872.

Mr. C. Dacres Bevan was one of those men of cultivated taste, who, although not himself working in the field of natural science, took a general interest in its advancement and aided in the support of what he saw must be a credit and advantage to the county.

We have also, in Mr. C. W. Boase, lost the bearer of a name which must always be regarded with high respect by the Society.

Nor can I omit to notice with regret the demise among our honorary members of Mr. William Lonsdale, in former years the assistant secretary of the Geological Society of London, one of the most modest and amiable of men, but one whose researches among the corals placed him, before his retirement from active life, in a very high position among the votaries of science.

I may now pass to the consideration of other topics; and, reviewing what has been set before you in the addresses of some years past, I am so much impressed with the importance of duly weighing and making the most of our present position, that I think it undesirable for the present to invite your attention to new discoveries at a distance, or to other matters bearing on our science at large.

This Society,—of which it is satisfactory to see to-day so goodly an attendance, was formed for the promotion of geological science by the personal observation of its members: and, as a corollary, it may be added that such observation would naturally be applied in

* "Modern Painters," Vol. IV.

the main to the phenomena of the mineral veins of the county, unsurpassed as they are in any country for their varied interest, and for their support through so many years of a large population, to the structure and history of the rock masses of the West of England, and to the collateral sciences and the analogous formations of other districts, which may throw a light on our more special subject matter. And in support of the assertion, that this task has been admirably fulfilled, I have only to remind you of the excellent material which has enriched your *Transactions*, from the days of our founders, whose names are still as household words among us, to the last volumes so industriously elaborated by Mr. W. Jory Henwood. The value of these contributions has been amply acknowledged—not only in all English-speaking countries, but throughout the civilized world, and reflects high honour on the men and the province whence they have emanated.

How is it then, that complaints are made of apathy in many who ought to be among the leaders in intellectual culture, of intelligence passed away and not re-placed, of the lack of appreciation of the value and interest of those studies which are in some respects as the foundation stone, whereon is built up so large a part of the property of Cornwall? My esteemed friend and predecessor, Mr. Tremenheere, has, only last year, most truly pointed out that the example of our earlier members proves that the pursuit of practical geology is not incompatible with the demands of a profession, of business, or of public life; and has answered the allegation of want of novelty in its results at the present day, by showing how much of startling novelty is still observable among the facts and views constantly accumulating by the workers in geology. Let me briefly indicate some of the prominent subjects which invite attention, and to which a residence in the Western counties aptly lends itself.

1st. Every new mine that is opened, every level that is driven in our existing mines, is capable, under discriminating observation, of yielding *data* more or less valuable in leading towards a comprehension of the complicated history of mineral veins.

2dly. The granite, elvan-dykes, and greenstones are far from being thoroughly understood, either in their actual nature or the *rationale* of their origin, and demand much further investigation and comparison with other districts.

3dly. The true position and relation of the sedimentary rocks of Cornwall are equally far from being settled. Since the period of De la Beche's survey, when the fossiliferous character of certain bands of the Killas was, very much against public opinion, fully established, a vastly increased interest has attached to your stratified clay-slates. Many and eminent explorers have entered the field, have sketched out-lines, and done much to elucidate the matter. Deductions have been, by no means, unanimous; and, since the well-sketched arrangements of Sedgwick and Murchison, a fierce war has for years been waged, in which the names of Salter, Jukes, Etheridge, and Holl are prominent, as to the true place of a large portion of the "Devonian" series of strata, which I need scarcely remind you includes a very extensive area in this county. Even in this very month our valuable, though rarely seen, member, Mr. Pattison, formerly of Launceston, in his own lively style combats the views of Dr. Holl, and vindicates the claim of the Petherwyn beds in North Cornwall to being truly Upper Devonian, holding the evidence sufficient to show that Cornwall really exhibits the triple natural-history division of the Devonian groups. That system, he remarks, was dragged out of the ocean of Grauwacke in 1836, after having been seen by Mr. Lonsdale, held up to public view by Sedgwick and Murchison, and duly passed into the literature of continental and American geology. His very readable paper in the *Proceedings* of the Geologists Association, which I commend to the pursual of every Cornishman, may serve as an instance showing how such an enquiry needs an acquaintance with the analogous formations of Ireland, of Belgium, France, and the Rhine; and promotes thereby a cosmopolitan interest in other countries, one soaring far away from narrow political jealousies, expanding our views and our pleasures, whether we have to pursue our studies in books at home, or follow them up with compass and hammer abroad.

4thly. The history of the "ups and downs" of the Cornish coast has yet to be written. What with its raised beaches, its submerged forests, and the wonderful conclusions to be drawn from some of the Tin stream-works (and I add nothing of grace of form and glory of tinting) no district of the same size in the whole world equals it in the interest of these more recent phenomena. Pre-eminent in its appeal to human curiosity is the unveiling—albeit only in brief glimpses—of the early scenes of mankind upon earth. An example of the strange results which may accrue from a close insight into some of these details will come before you to-day. My brother-in-law, Professor Flower, with a very pronounced love of animals and their bones in general, cherishes I believe a special liking for whales, and no sooner entered your hall one day last spring than he saw that the bones of a whale, which had been lodged in your museum many years ago, belonged to no kind known to exist at the present day. He finds that it is one of the *Balænidæ (Eschrichtius robustus,)* which has been described chiefly from a more perfect set of bones found in the Swedish island of Gräso in the Baltic. Mr. Colenso described in your *Transactions* the section of the stream deposits of the Pentewan valley, whence it appears that far below the remains of this whale and a series of sea sands, came the usual forest-bed, and deer's horns, a human skull, and wood cut by human hands. Hence we get, in addition to the various conclusions as to the depression and subsequent up-rising of this part of the coast, the notable deduction that this strange Cetacean was stranded long after our remote ancestors had been hunting red deer in this wooded valley, and has become extinct since Cornwall was inhabited by man.

I may spare you the recital of farther instances, but will notice how one idea will be apt often to crop up from them—that students must, in order to observe, have opportunity of not merely seeing but poring over collections. Hence the value of Museums such as ours partly is, and partly ought to be.

It is not without interest to note how similar thoughts animate the active minds occupied in organizing intellectual society on the

shores of the Pacific. A few posts ago I received from a friend in California, the account of a grand reception to Professor Agassiz at the Academy of Sciences in San Francisco. In his eulogy of what has been accompished at Cambridge, Mass., and his encouragement of the efforts making by the friends of science in California, this great naturalist especially dwelt on what is required to make observers:—"That is what the world wants—not books to read, but it wants men to learn what is not yet known. These men cannot be educated in the school-room. They must be educated in the School of Nature, among her specimens. Knowledge must be obtained, and from where are these materials to be forthcoming? The student has not time to go into the field and gather his materials for work. He must have such aid, and must have such stores, as will bring the facilities for study closer to his laboratory."*

The instruction to be thus obtained from the systematic and long continued use of a suitable Museum is, of course, of a different degree from the more general scheme of elementary education which formed the subject of so much careful enquiry by your late President. The Council has not as yet been able to see its way clearly to taking steps in that direction.

But one pressing matter, also urgently recommended by Mr. Tremenheere, has received attentive consideration, and should we think at once be commenced upon. It has, for just 30 years past, been desired to obtain space and proper accommodation for the fossils, without an exhibition of which the geological aspect of your Museum almost disappears, whilst the student of the science has no chance of profiting by the large store which the Society possesses. Mr. Bettany, Jun., has, with commendable industry, explored the whole of the collections, and drawn up an excellent report, with suggestions as to what should be exhibited. The fossils are there, and a spacious room is there: cases, drawers, and judicious arrangement, not the least item among the *desiderata*, are wanting. We propose that, as a beginning, six cases should be prepared, nearly similar

* Mining and Science Press, San Francisco, 7th September, 1872.

to the table-cases in this mineralogical room. Three of them might be appropriated to the Cornish fossils, three others to a typical collection designed especially for the aid of those who wish to learn the application of this study to stratigraphical geology. But, even a small outfit of the kind costs money, and the Society, although as your Treasurer will show, nearly out of the mire of debt, is scarcely able to undertake for the present so heavy a charge.

Again, at this juncture, as has occurred on previous occasions, one of our lady members, ever prompt to acts of wise generosity—and to but few in this room need I mention that this lady is Miss E. Carne,—comes forward and offers a handsome donation on condition of the Society's also taking part in the outlay.

There is thus at length set before us a prospect of the commencement of a new order of things. With a mineralogical collection alone we were manifestly very defective, notwithstanding the interest, especially in a mining district, of the objects thus exhibited. But in now preparing to support and aid in his studies, on the one hand the practical miner, on the other the cultivated reader, who desires to obtain a distinct idea of the succession of strata and the forms of life which distinguish them, the Society is, I trust, cross-cutting into a parallel lode which will prove at least as rich as the one which they have for years been working to profit.

THE FIFTY-NINTH ANNUAL REPORT OF THE COUNCIL, 1872.

THE Council, on the present occasion, have not much to say to the Society, but all that is worthy of report is of a highly satisfactory character.

The labours of the same friends, who have always been conspicuous for their kind and zealous exertions in the museum, have at length produced the long-expected catalogues of the metallic and earthy minerals, contained in our central cases. These catalogues are far from being complete in all their details, owing to the deficiencies of our records; but their defects will, it is confidently hoped, be in time remedied, or future additions to the museum will be entered with due regularity and scientific precision.

The museum itself, during the past year, has been greatly enriched by the present of copper-ores, &c., of South Australia, received from Mr. Samuel Higgs, jun., the former Secretary of this Society, now so usefully employed as superintendent of the Wallaroo and other mines in Yorke Peninsula, and also by an interesting collection of Tertiary fossils from the same quarter.

The special thanks of the Society are due to Mr. Higgs for his welcome gifts. Some of the muriates and carbonates of copper, from Burra Burra, Moonta, and Wallaroo, are very beautiful, and with the molybdenum specimens, supply an hiatus in our metallic cases which has long existed. The donor left the disposal of the spare duplicates to his and our friend, Mr. Henwood, and on that gentleman's recommendation presents have been made to the Museum of Practical Geology in Jermyn-street and the Royal Institution of Cornwall at Truro. There are enough specimens still remaining for six or seven public institutions, the selection of which will be made by the President. Mrs. Gandy's contributions of fossils from

Normandy, collected by the late Mr. Gandy in that province, chiefly belonging to the Oolite and Lias series, form a notable addition to the Museum.

The paper, which will to-day be read, in regard to the entire collection of fossils, will shew that, even before the receipt of these valuable gifts, the fossil property of the Society quite deserves the character accorded to it by our late President in his addresses on this subject.

The Council are glad to signify their acceptance of Miss Elizabeth Carne's liberal proposition to hand back to the Society her annuity of £20 for the present year (derived, as the Society are aware, from her generous arrangement in liquidation of our debt), on condition of its being met by an equal, or something less, contribution on the part of the Society for the purpose of fitting-up the lower room of the Geological Buildings with appropriate cases for the display of our fossil wealth.

The Council take this opportunity of acknowledging, with thanks, the labours of Mr. G. T. Bettany, B. Sc. Lond. and Tancred Scholar of Caius Coll., Cambridge, in the palæontological department of the Museum; shewn by the paper now to be read, and commend to the coming Council the immediate consideration of the necessary fittings for the fossil room down-stairs.

The Council have reason so believe that before the next annual meetlng Mr. Ray Lankester will supply his long expected report on the valuable Devonian Fossils in the Museum, contributed by Messrs. Peach, Pattison, and others. While on the subject of the Museum, the Council are happy to report the continued very large resort of visitors, among whom this year's list shews the interesting names of members belonging to the Japanese Embassy, whose visit to Cornwall and its Mines is expected to produce useful results in their native country.

The Librarians' Report shews some important contributions to the Society's shelves, among which may be mentioned, with satisfaction, the large presentation of books from the Geological Survey

Department of Canada (some officers of which visited the Museum during the year); and, recently, the first of a series of reports of the Mining Department of Netherlands India, kindly presented to this Society, with promise of future numbers by the Netherlands Government, through the British Secretary for Foreign Affairs.

The Council confidently rely on the promise of the Librarians that another year will not pass away without the preparation of a complete catalogue of the library, which is daily becoming more valuable; and they relegate to the coming Council the duty of providing for the proper binding of the present large collection of periodicals.

The Council congratulate the meeting on the printing and publication of a further series of the Society's reports, viz, 56, 57, and 58, bringing up its history to the present date. In a few days these Reports will be in the hands of every member of the Society, and their contents will shew how large a debt is due to the zeal of its last President, Mr. H. S. Tremenheere.

The Council would now urgently commend to the Committee of Papers the propriety of taking stock of all the existing unpublished papers, not yet forming parts of the Society's *Transactions;* and, if possible, providing for a periodical publication, which will prove, as formerly, the useful *continuous* existence of this Society. Among such papers it will be necessary to consider the valuable and important catalogue of Cornish Works on geology by Mr. W. Whitaker, F.R.S., which has only just now been received, and which has been offered to the Council for publication among our own works, if thought proper.

The Treasurer's report shews that the debt of the Society is being reduced within moderate limits; and thus funds will be available for some of the objects—if not all—contemplated in Mr. Tremenheere's plans and addresses.

In conclusion, the Council beg to record, with regret, the death during the year of the Society's former eminent President, Mr. Augustus Smith, and of their old friend and trustee, Mr. John

Samuel Enys. They also regret the loss of Mr. C. W. Boase, an honorary member, and Mr. C. D. Bevan.

The Council request authority from the Annual Meeting to appoint a Trustee in the room of the late Mr. Enys.

J. H. BATTEN, *Secretary.*

LIBRARIANS' REPORT.

Presentations—

1.—The Earth. Presented by H. S. Tremenheere, Esq., C.B.

2.—Account of Scientific Works, from the Editor, M. Delesse.

3.—Report of the Commissioners to enquire into Coal. Presented by J. St. Aubyn, Esq., M.P.

4.—Pamphlet on South Africa and its Diamonds, by Thomas Rupert Jones, F.G.S. Presented by Prof. J. Tennant.

5.—Principles of Chemical Philosophy, by the author, Josiah P. Cooke, Junr.

6.—Report of Meeting of Miners' Association of Cornwall and Devon, held at Breage, by A. Pendarves Vivian, Esq., M.P.

7.—Note on Pyrites Deposits in Spain, by the Author, S. R. Pattison, F.G.S.

8.—Mineral Wealth of the United Kingdom, and Mechanical Representation of Geological Phenomena, by the Author, Professor Tennant, F.G.S.

9.—Palæontologia Indica pt. 9-13. Records of Geological Survey of India, Observations on Geology and Zoology of Abyssinia, by Blandford. By Government of India, through Geological Survey of India, Calcutta.

10.—Remarks on Successive Mining Schools of Cornwall, by the the Author, J. H. Collins, Esq.

11.—Memoirs of Geological Survey, Ohio, U. S., Catalogue of Ohio Valley, by Messrs. R. Clarke and Co., Cincinnati.

12.—Address of President of the Botanical Society of Edinburgh, with list of Provincial Scientific Societies of Great Britain and Ireland, by Sir Walter Elliott, K.S.I.

13.—Notice of a Sub fossil Whale discovered in Cornwall, by the Author, W. Henry Flower, Esq., F.R.S.

14.—Observations on the Metalliferous Deposits of Cornwall, by the Author, W. J. Henwood, Esq.

14.—Geological Survey of Canada from 1858 to 1871, by Alfred R. C. Selwyn, Esq., F.G.S., Director.

16.—Annual Report on the Mines of the Netherlands India, by the Netherlands Government through Secretary of State for Foreign Affairs.

SOCIETIES' PROCEEDINGS, TRANSACTIONS, REPORTS.

1.—American Philosphical.
2.—Geological.
3.—Royal.
4.—Geologists' Association.
5.—British Association.
6.—Miners' do.
7,—British Naturalists.
8.—Royal Society of Edinburgh.
9.—Royal Cornwall Polytechnic.
10.—Palaeontographical.
11.—Smithsonian.
12.—Institute de France.

Magazines—

1.—London Edinburgh and Dublin Magazine.
2.—Annales des Mines.
3.—Western Chronicle of Science.

Various—

1.—Handbook of Mineralogy of Cornwall and Devon, by J. H. Collins, Esq.
2.—Les Oscillations des Côtes de France, by Delesse.

3.—Reports of the Mining Surveyors and Registrars Victoria.

4.—Mineral Statistics of Victoria.

5.—Report of Westminster Hospital and Medical School.

6.—Meteorological Report for Penzance 1871, by Mr. W. Hosken Richards.

Presentations on the day of meeting—

1.—Portrait of Mr. Robert Hunt, F.R.S., by Mr. S. Higgs.

2.—Eight Volumes of the Geological Magazine from the commencement, by Mr. W. J. Henwood, F.R.S.

3.—Brief account of some travels in Europe, by Edward Brown, M.D., 1685. By the President, Mr. Warington W. Smyth.

E. H. RODD,
C. C. ROSS, } *Librarians.*

25th October, 1872.

CURATOR'S REPORT.

DURING the past year the following presentations have been made to this Society.

By Mrs. Gandy, of Rose Hill, Marazion,—

A large collection of Fossils, from Normandy. This collection was formed by the late Mr. Gandy, Member of the Linnean Society of Normandy.

By Mr. Samuel Higgs, jun,—

Copper Ores, Molybdenum, &c., from Wallaroo District, Moonta, Spring Creek and Burra Burra, South Australia, and a series of Tertiary Fossils, from Yorke's Peninsula, South Australia.

By Mr. Michael Beazely, C.E.; of Penzance,—

A Specimen of Crystallized Steam Coal, from Cardiff.

By Mr. Arthur Begbie,—

Samples of Iron Ore, from West Down Mine, near Lanivet, Bodmin.

By Mr. Warington Smyth,—

A Specimen of Molybdenite with Pyrites in Porphyry, from Tomnaclashun, Lock Tay, Scotland.

By Mr. William C. Borlase,—

Flints from Goonhilly, near the Lizard, and from Trevelgue, St. Columb Minor.

By Mr. Warington Symth,—

A Specimen of Zinc Blende (highly crystalline), from the deep working of Laxey Mine, Isle of Man, and a Specimen of Brown Iron Ore (Belfast Ore) containing a large percentage of Alumina, and very largely employed in the Cumberland works for making Bessemer Iron.

GEORGE B. MILLETT,

25th October, 1872. *Curator.*

TREASURER'S STATEMENT, 1871-2.

RECEIPTS.

	£	s.	d.
Donation H. R. H. The Prince of Wales	20	0	0
Two Life Subscriptions	21	0	0
Ordinary Subscriptions and Arrears	97	13	0
Proceeds of Sale of Vol. 8 of Society's Transactions	65	9	0
Balance due to Treasurer	65	2	7
	£269	4	7

October 25th, 1872.

EXPENDITURE.

	£	s.	d.
Balance from 1870-1	186	11	0
Rates	0	8	0
Housekeeper and Coals	8	9	0
Insurance	2	12	9
Expenses of Secretary and Treasurer	4	7	3
Advertising	1	18	6
Subscription to Palæontographical Society	1	1	0
Life Annuity to Miss E. T. Carne	20	0	0
Printing and Stationery	2	4	3
Sundry Bills	1	16	8
Interest	5	2	10

EXTRAORDINARY EXPENDITURE.

Messrs. Perkins and Caldwell, New Case	9	0	0
Messrs. Freeman	10	0	0
Messrs. Olver and Son, Museum Fittings, &c	15	13	4
	£269	4	0
Balance	£65	2	7

Wm. BOLITHO, Jun., *Treasurer.*

LIST OF PAPERS READ AT ANNUAL MEETING,

OCTOBER 25TH, 1872.

1.—A Report on the Geography, Geology, &c., of the Mining District of Yorke's Peninsula, South Australia, by Mr. S. Higgs, jun., F.G.S. Read by the Secretary.

2.—Description of the Bones of a Whale found at Pentewan, and belonging to the Museum of this Society, by Professor W. H. Flower, F.R.S. Read by Dr. C. Le Neve Foster.

3.—Notes on the Fossil Collections belonging to the Society, by Mr. G. T. Bettany, B.Sc. Read by the Secretary.

4.—Remarks on Fractured Flints found in various parts of Cornwall, by Mr. W. C. Borlase, F.S.A.

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

THE

SIXTIETH

ANNUAL REPORT,

&c., &c.

PENZANCE.

1873

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:

Her Most Gracious Majesty The Queen.

Vice-Patron:

His Royal Highness the Prince of Wales, K.G., &c., &c.

Trustees:

Mr. T. S. Bolitho.
Col. Tremayne.
Mr. Le Grice.

OFFICERS AND COUNCIL FOR 1873—4.

President:

Mr. Warington W. Smyth, F.R.S.

Vice-Presidents:

Viscount Falmouth.
Mr. H. S. Tremenheere, C.B.
Mr. D. P. Le Grice.
Mr. A. P. Vivian, M.P.

Treasurer:

Mr. William Bolitho, Jun.

Secretary:

Mr. William C. Borlase, M.A., F.S.A.

Librarians:

Mr. C. C. Ross.
Mr. G. B. Millett.

Curator:

Dr. C. Le Neve Foster, F.G.S.

Assistant Curator:

Mr. G. T. Bettany, B.Sc.

Council:

The Officers of the Society

Mr. T. B. Bolitho.
Mr. John Dennis
Dr. C. Le Neve Foster.
Mr. Robert Fox.
Rev. Preb. Hedgeland.
Mr. E. H. Rodd.
Mr. W. H. Rodd.
Sir John St. Aubyn, M.P.
Mr. W. B. Smith.
Col. Tremayne.
Mr. R. Tweedy.
Mr. J. M. Williams.

PRESIDENT'S ADDRESS.

In following the example set by my predecessors in this Chair, of addressing you on some of the prominent topics affecting the aims and condition of your Society, I am conscious that there is no one present in this assembly who will not feel that one sad subject demands our first attention. We miss to-day the presence of one who alike by her intellectual power, her generosity, and her cheerful industry, has for years past in the highest degree fostered and advanced the interests of the Institution. By the recent death of Miss Elizabeth Carne, we have lost, not only a munificent donor on all occasions when assistance was needed,—but a kind friend ever ready to volunteer counsel or aid by work of hand or head, wherever her quiet judgment suggested that they would be welcome. In this spacious apartment, where without Miss Carne's generous boon, we should scarcely have been able to meet this day, it is perhaps not the place to refer to her noble and discriminating charities, and to the numerous deeds of goodness upon which many a tongue in this neighbourhood would gladly dilate. But it is especially here that we cannot neglect to dwell upon the admirable work done in our own particular sphere, and on the useful example set by a life so wisely spent. Few of my auditors will be unaware that when a large amount of debt appeared likely to interfere with the Society's enjoyment of its new buildings, this public spirited lady at once undertook on easy terms to arrange for the payment of £500 of it. And probably not many, during the first year or two of occupation, braved the dust and incompleteness of this and the lower rooms, to see our lamented friend assisted by her excellent and unwearied elder sister plodding for month after month in grouping, placing, and labelling the Society's specimens. Made over to the

volunteered charge of these assiduous ladies, the thousands of examples of minerals which fill the cabinets around you owe their brightness to actual hard work, their arrangement to judgment in studying other collections, and their labels to the manipulation of a little printing press in your basement story.

In her varied acquirements, as an observer in geology and natural history, and in her facility as a writer, Miss Carne followed worthily in the footsteps of her father, Mr. Joseph Carne, one of the founders of this Society, and of her uncle, whose "Letters from the East" formed one of the best books of travel of the last generation. Mr. Joseph Carne's papers were of high interest in the first year of the existence of your Transactions. Miss Carne's would be suggestive and valuable to us now; but with much regret we have to confess that certain of her original observations commuicated to our meetings are not yet printed,—and it may be hoped that this thought will lead to an effort being made to bring up the arrears of publication. Although scarcely within the province of an obituary notice from this chair, I may be pardoned for referring to the last work of Miss Carne, "The Realm of Truth," completed but a few months' ago, and evincing a thoughtfulness and a power of searching out the motives of human action, which illustrate much of her career, especially her unobtrusive knowledge and charitable actions. In stripping bare the meaning of the worldly theory of excellence,—"What!" she exclaims "is not the charm "of knowledge enough to rouse the desire to know? Is not the "beauty of Nature and Art enough to make us its willing "worshippers? Are not truth and goodness, justice and right, "enough to stimulate us in what we seek, and in what we do? If "not, we are dangerously, fatally, languid in our response to all that "should constitute our strongest motive power."

And it is touching to observe the authoress—in the last few weeks of her life trustfully looking forward to the "home of true things," where

> Knowledge shall never more deny
> Our quest unsatisfied;
> We shall not gaze despairingly
> Across that ocean tide:

And Truth shall stand in her own land
In bridal splendor dressed,
A craving stilled, a hope fulfilled,
Beloved, desired, possessed.

One of our Honorary Members, lost to us by death since our last meeting, Professor Sedgwick, played so important a part in the history of modern geology as to require from us, notwithstanding the numerous biographical notices of him which have been published, something more than a passing reference. Born in 1785, at Dent in the hilly district of North Western Yorkshire, Adam Sedgwick was brought up in a region where the regular stratification of the Carboniferous limestone and the various characters of its subdivisions could hardly fail in attracting the attention of an observant lad. He studied at Trinity College, Cambridge, became 5th Wrangler in 1808, and ten years later, was appointed Professor of Geology, although it does not appear that up to that time he had devoted much labour to the subject. But his industry, good mathematical drilling, and genius, placed him in a very short time among the foremost of the cultivators of our science. The first account which he gave of his own observations was a communication to the Cambridge Philosophical Society in 1820, on the physical structure of Devon and Cornwall. And indeed so numerous in his days of strength were his contributions to the knowledge of our South Western regions that his name should stand for ever as one of those who deserve well of this county. Besides notices of the Lizard, and sundry other minor papers, he treated in a series of discourses on the clay-slate or killas, and latterly in conjunction with Sir Roderick Murchison arrived at those conclusions which led to the establishment of a "Devonian" system, and indeed of the views of the structure of the bulk of Cornwall, which still in great measure prevail. For a confirmation of their views these authors examined with unflagging energy large districts of Belgium and Germany, in which countries the Devonian strata were soon recognised, and where in fact all further study, carried out in great details by the Belgium and German geologists, appears to have resulted in establishing the same general tenor of succession.

Sedgwick's subsequent labours in the Magnesium Limestone of Northern England, and upon the older schistose rocks of Cumberland and of North Wales, interest us perhaps less in these Western regions, but are models of spirited, energetic observations and of bright thoroughly descriptive writing. And yet, having from boyhood up had the privilege of his acquaintance, I feel convinced that Sedgwick is entitled to hold a much higher place among England's worthies than ever could be accorded to him by the public on persual of his many writings, popular as some of them have been, especially his "discourse on the Studies of the University." The keen sense of humor which enabled him todescribe a comical scene with irresistible effect, was interwoven with a natural eloquence, which at times would burst forth impetuously, and move a whole audience to euthusiasm or to tears. His lectures were frequented by many who cared less for the subject than the way in which he treated it, and his field lectures, done principally on horse-back, were an event in the fen-country, no one enjoying more than the Professor himself the enquiries sometimes put to him by the rustics, as to "where the fight was to come off,"—imagining that nothing less than a fistic encounter could attract so many sporting men.

But added to the intellectual strength, and to the zeal and liberality with which he remodelled, not alone the Museums of the University, but the very idea of what they should be, Professor Sedgwick possessed other qualities which in the highest degree endeared him to his friends and latterly indeed, when he was thoroughly well-known, to all Cambridge. His unswerving uprightness, incapable of the smallest approach to equivocation, his kindness to all ranks, and his honest out-spoken hatred of injustice, stamped him as no ordinary character, and combined with his other powers, rendered him a very "king of men."

We have also lost from the list of Contributing Members, a representative of the sister university, in J. H. Peter, Esq., of Chiverton, near Truro, who though he obtained a fellowship at Merton College, Oxford, and was acquainted with many matters relating to our Science, does not appear to have worked at the subject or to have attended our meetings.

The death of Sir Edward St. Aubyn, Bart, has robbed us of the chief representative of one of the oldest Cornish families—yet every Member of the Society will feel the satisfaction of his place in the county being so worthily filled by his successor.

In my address of last year I brought before you a topic which for some thirty years past had more or less enjoyed the attention of your leading members, viz: the utilization of the Society's collection of fossils. The excellent report prepared by Mr. Bettany, Jun., rendered it clear that a valuable series of collections had been accumulated, chiefly by donations, but partly by special purchases, which so long as they remained packed in boxes or closely stowed pell-mell in drawers, were practically useless. Until indeed they could, on some definite plan of arrangement, be exhibited, the Society was not acting up to what might be expected of its "name and fame," withholding from its members the opportunities of instructing themselves in the very basis of stratigraphical geology, and giving to the public only a one-sided or partial view of the objects contemplated by our Science. That reproach has now to some extent been removed by a commencement, and as it is notoriously *le premier pas qui coute,* we may hope that ere long, a much fuller display will minister to the attraction of your fossil-room. We have to thank Mr. Bettany, jun., for the gratuitous services rendered in arranging a characteristic series in two of the table cases, which you will have remarked on entering our rooms, and now hope that he will be able to fulfil his promise with regard to the other two cases on the West side of the room, and which are at present occupied only temporarily by fossils of the Chalk and of the Tertiary Series, and by an illustration of the flint knives and axes, and of the cave bones of Southern France, which have invested the Pleistocene deposits with so surprising an interest.

The table cases put in order contain the groups of fossil organisms illustrative, in the two first quarter cases—of the Lower and Upper Silurian divisions; in the third, the Devonian, and Mountain Limestone.

These we shall hope to see well supplemented by additional examples to serve as standards of comparison with those of the various Cornish fossiliferous localities which will be exhibited in the cases not yet arranged. In the fourth quarter-case a moderate representation of the coal-measures is given, and on the West side of these several compartments, the qurassic system (the oolite) comes in with a great fulness of fossil forms. Hence a little sketch of palæontology is placed before the eye, which, mere outline as it is at present, nevertheless enables the Society to fulfil its duty of aiding the student or even the reader, whether among our own members or among the enquiring part of the public who, in yearly increasing numbers visit the collections.

To turn now from the biological to that department of geology to which this Society has very naturally devoted its chief attention, I mean, in its connexion with minerals and mines, we who are assembled in a district where tin-mining dates back from beyond tradition, where tin smelting works pour their blue smoke to the right and the left of us, and almost within sight of mines, (Wheal Fortune and Wheal Vor) where steam engines were erected half a century before Watt and his improvements appeared on the stage; we, surrounded here by a population in which so many depend on the success of mining—cannot but give expression to the anxiety with which, now, the prospects of the mines must be regarded. That there have been other periods of depression and alarm which have been successfully overcome, is better known to many of you than to myself. Nowhere perhaps can we more plainly read the fears of a time of distress than in the memorial presented to Parliament, by the "Gentlemen adventurers in Tin and Copper Mines in the County of Cornwall, and the inhabitants of the said County"—a document supplied by Sir Charles Lemon to Professor Pole for publication in his treatise (published in 1844) on the Cornish Engine, and believed to date from before 1730.

"For many years past" it states, "there have been no new "lodes or veins either of tin or copper discovered; and by the "extraordinary and indefatigable labour of the miners, the county

"has been so entirely tried, that there is not the least reason to "expect there will be any, so that unless some means can be found "out to work the old mines to advantage, there is the greatest "probability that the commodities of tin and copper will in a few "years greatly decrease."

The precise object of this memorial was to obtain the redress of the grievance of the excessive price of coal caused by the heavy duty on sea-borne coal, stigmatized as glaringly oppressive, in as much as it amounted to full *fifty per cent* upon the price paid to the coal owner for the coal. Who could have imagined that above a century after this injurious tax was remitted by Parliament, our mines should, in common with the whole people, be subjected to a still harsher and more cruel tax, which, with no scarcity of the article to warrant it, is adding, not fifty, but *a hundred per cent*, to the ordinary price, and thereby threatening with absolute destruction a large proportion of the mines in which steam power is indispensable.

It is curious to compare the present with that earlier period of distress in regard to the dearth of good discoveries of tin or copper.

This having been the rule—with but few exceptions, for the last twenty years, has doubtless tended much to check the spirit of adventure and exploration, without which mining must gradually languish. But what a lesson do we read in those doleful lines! what an encouragement to perseverance and hope, when we recall the brilliant history of Cornish mining for a period of 140 years after they were penned! What an absurd—because ignorant—despondency, —"*the county so entirely tried that there is not the lest reason to expect any new discovery*"! And yet, since that time we have had Cornwall for more than a century at the head of the tin and Copper production of the world, we have had individual mines in numbers opened and profitably worked, and entire new regions of lodes, Fowey and Par Consols, the East Wheal Rose district, that of Menheniot, and the Caradon mines, discovered and brought into action on the grandest scale. As for exhaustion of area, a glance at lode—maps like those of Symons, and a little enquiry, will show the vast number of mineral veins just known but only

slightly explored, besides which we may fairly presume that numbers more are at present unknown. Is it suggested that our workings are too deep to hold much farther,—we must admit that the expenses attendant on depth are a serious draw-back, but yet may point to lodes like those of Dolcoath and Tincroft as continuing downward with undiminished strength in the nethermost levels, and after all, our two or three hundred fathoms of depth, whilst it is nothing to the eye of the speculative geologist, is far exceeded by several of the European mines. I had in May last the satisfaction of inspecting several successive workings between 410 and 470 English fathoms deep, at the productive Silver-lead mines of Przibram in central Bohemia now continuing to deepen after 121 years of presistent profits. The "Adalberts," one of a series of several spacious perpendicular shafts, has actually attained a depth bordering close upon 500 fathoms. The lodes in these bottom levels maintain their full average size, commonly from 4 to 8 feet wide, and bear decidedly a larger average proportion of silver than in the shallower parts of the workings. And as a proof of its being no mere bunch, no accidental run of luck that has encouraged so remarkable an activity in sinking, I may add that long ranges of levels are opened on some 29 lodes, of the 1st grey wacke zone—in Barrande's *étage* B of the Silurian, and that whilst at least half the men are always employed on exploratory work, the reserves are estimated to amount to no less than thirty years of the present out-put, of about 48000 lbs. Troy of silver per annum.

Unfortunately for the prospects of the Western Mines of England, not only do the natural difficulties of the ground encounter them, but the coal owners, coal-dealers, and colliers combine to work them woe, and formidable rivals from various quarters introduce their easily won stream-tin to the markets, where Cornish tin used to reign supreme. No sooner are we somewhat relieved from the pressure of the East Indies, than New South Wales, Queensland, Victoria, and Peru unite in a joint commercial attack, and now, as we read in last week's Mining Journal,—Van Diemen's land boasts the discovery of these ores in such quantity that the sides

of the pits are reported as black with tin-stone, and masses of it rise in the broil of the lodes to twenty feet above the surface.

The Report on the Queensland discoveries by Mr. Gregory, the mineral Lands Commissioner at Stanthorpe, the observations on those of New England, by Mr. Ulrich, F.G.S., and the remarks by Mr. Daintree,—all published in the Quarterly Journal of the Geological Society for February last, were such as to surprise, and it may fairly be said to alarm the most in-curious. Mr. Gregory, from abundant exploration, estimated the area within which tin had been found at 500 square miles, of which he concluded that the half or 225 square miles were sufficiently rich in tin-ore to pay for working. Further, on "very fair data," he computed that along 140 miles on the Severn Waters, and thirty more on the tributaries to Pike's Creek, an average of ten tons of black tin per linear chain would represent the amount of this mineral to be raised from alluvial working alone. Thus we have, on what ought to be good authority, about ten millions of pounds worth lying close to surface, and irrespective of the lodes on which the Commissioner expresses himself cautiously. It is interesting to find that the tin is associated, as usual, with our old friend the granite, and Mr. D'Oyley Aplin, not quite in harmony with other observers, states that the felspar of this rock, wherever he has seen it "is a pink or "red orthoclase, and the mica generally black, but when crystals "of tin ore are found *in situ*, the mica is white. The granite "generally is coarse grained, and seem to disintegrate readily under "atmospheric influences. There are numerous bands of loosely "aggregated rock, granitoid in character, highly micaceous, and "traversed by bands and veins of quartz in all directions.

The strike of the bands and the distinct quartz veins in the "granite is generally North East and South West." How suggestive is the similarity between these characters, and those of many of the European tin-bearing localities—rather, as I think, those in which the "old men" worked with their hundreds of shallow pits and *coffins*, but which have not held out to make rich mines in depth.

Mr. Ulrich describes highly interesting mineralogical details of the property of the Elsmore Company, especially as to the fine *vugs* with crystallized cassiterite and interlacing beryl. He also describes, both stream-tin and lodes traced away for some little distance from the granite into the overlying black schistose rock; and without venturing on an estimate of total quantities, he gives a glowing account of the results of "tin-dish prospects of granite detritus" which he saw washed, which being interpreted from the Australian language means the trials by vanning, said to yield in numerous cases for 20 lbs. weight from 3 ozs. to 2 lbs. of black tin.

All this is of course to us at home highly disquieting, but although such reports render it quite certain that a very large amount of tin or its ore will make its way to this country, we have to remember that many of these and similar descriptions are indited by persons not practically conversant with tin streaming or mining, and that exaggeration is sure to follow even among truthfully disposed people, on the discovery of new and surprising things. Already it is matter of notoriety that the drawbacks prove to be manifold, that many of the companies have ceased working, and that scarcely a single instance of the successful working of a lode can be brought forward.

The official reports published in 1872 in the Supplement to the British Burmah Gazette, contain detailed descriptions by Mr. Mark Fryar on the stream tin deposits of Ténasserim. His examination of the Thabowleck river not far from Mergui—reported on in 1843-5 by Capt. now Gen. Tremenheere—of the Palouk river, Maleewoon, and other localities, gives the impression of works of long standing, carried on by a very moderate force of Chinamen, and not likely to increase their production in any notable degree. Maleewoon, on a tributary to the Packchan river, is leased to one Tsit Tschan, a Chinese employing about 200 men. "In deference" says Mr. "Fryar, to their superstitious belief in the influence of Nats "(spiritual intelligences) over the productiveness of their tin-stone "places, I had to take off my boots, while examining the excavated "faces of the stream-beds. Close to the excavation and on the top

"of a heap of washed *debris*, a house has been erected and mounted "with white flags, for the purpose of propitiatory offering to the "Nats, and the agent complained that on some former occasion a "European gentlemen had walked about the place with his boots on, "and that as a consequence the tin all went away and only returned "after costly sacrifices of buffaloes had been made as offerings of "atonements to the Nats."

It is perhaps hardly needful for me, considering where we are, to apologize for dwelling so long on what may appear rather a commercial than a scientific subject, but we must be pardoned for an instinctive jealousy in regard of this one particular metal. To the loss of the foremost place in copper mining we are becoming inured, and the historical student will add it to the remarkable cases, in which the need of excellence passes now to one, and by and by to another country. An interesting contribution to this department of history has this year been made by Mr. R. N. Nasse, of Boun in his description of Laurion in Attica. Here were mines of silver-lead, worked on an enormous scale in the palmy days of Athens under Perikles, and mentioned by Strabo in the first years of the Christian era as being worked out and giving employment only to a few persons dressing up the refuse. In the second century they seem to have utterly ceased, and were forgotten except by the classical student who scanned the curious literary relics which had been handed down, and which were summed up in the masterly treatise of von Boeekh, "Die laurischen Bergwerke in Attica." Berlin 1814. Now, however, what a turn in Fortune's Wheel! an observant Frenchman, examining piles of slags and of the refuse of dressing works, forms a French and Italian Company, Roux & Co., starts in 1864 a smelting work in the Bay of Ergasteria, near a pile of some 300,000 tons of slags, and in a short time makes such a profit as to excite the cupidity of the Greek government and to lead to a complication which recently threatened to bring on warlike demonstrations by France and Italy against the petty but provoking Greek Kingdom. And now with the farther progress of their successful company, and the trial operations of several

others who have obtained extensive setts for mining, it seems not improbable that these mines, overlooked for 16 centuries, will again form the centre of an active production.

Here we have a link with men of a remote past in which we find geological enquiry merging into archœology,—and I cannot omit in conclusion to call your attention to two works which have appeared within the last year and should especially be studied by those interested in the earliest traces of man's presence in this Bolerian peninsula.

That unwearied collector and arranger of facts, Sir Charles Lyell, has published a fourth addition of his "Antiquity of Man," in which he has added to his former captivating treatise an account of the Belgian Government's exploration of the caves of the Lesse, and of his own recent visits to the caves of Aurignac and the Dordogne in Southern France. And going back not quite so far into the past, but inosculating into the same subject, our Honorary Secretary Mr. W. C. Borlase, has given us in his *Nœnia Cornubic* a book in which the megalithic element is so strong as almost to stamp it as a work of applied geology, whilst the scientific treatment of the details of the sepulchral relics of this county entitle the author to the thanks of all those who are not blind to the interest of the early history of the British race.

COUNCIL'S REPORT, 1873.

THE Council for the past year have again to perform the pleasing duty of congratulating the Society on its continued prosperity, on this its Sixtieth anniversary.

At their first quarterly meeting, according to the powers given by the General Annual Meeting, Col. Arthur Tremayne was appointed a Trustee of the Society in the room of the late lamented Mr. J. S. Enys.

As will be seen from the Curator's Report, the fossil room contemplated in last year's proceedings has been put in order, and fitted with four new cases. These have been already partially arranged by Mr. Geo. Bettany, jun., and the Council look forward with satisfaction to the prospect of the completion of the work in the course of the current year.

In the department of the Library, considerable progress has been made in cataloguing the books; and the Council recommend that, in accordance with the wishes of the Librarians, additional book cases be set up. During the preparation of the report, the Council have had the satisfaction of receiving from Miss Elizabeth Carne's representative, Mr. C. C. Ross, a letter expressing his desire to devote the sum of £20 due as annnity to his late Aunt towards supplying the deficiences in the Library.

The Prince of Wales has received through the President a copy of the Society's Transactions, Vol. VIII; and his Royal Highness has been pleased to tender his thanks for what is described as "so interesting a work."

The Committee of Papers have hitherto been unable, in view of the pressing necessity of setting up the Fossil Museum at a considerable expense, to carry out the Resolution of last year with

regard to the publication of any further Transactions, but hope to do so in the year now commencing.

During the year under Report the Society has had occasion to lament, in common with the world of Science, the death of their old and eminent Honorary Member Professor Sedgwick.

Among ordinary Members Sir Edward St. Aubyn, and Mr. John Henry Peter have been removed from amongst us. When on the last Anniversary, as on so many others, the Council had to report a fresh act of liberality on the part of Miss Elizabeth Carne in regard to the liquidation of the Society's debt, they little contemplated the sad event which has so recently deprived them of their kind benefactress and indefatigable friend. In sincerely deploring this great loss and paying their own tribute of respect to her memory, the Council are well aware that they only represent the unanimously deep feeling of this Society and Meeting; and that they are sharing a sorrow which may truly be called Public.

The fact that our worthy Secretary, Mr. J. Hallet Batten, has now ceased to reside amongst us, and has consequently resigned his office, must be a matter of regret to us all. To his constant attendance on the spot, and to the untiring assiduity with which he carried out the duties of his own post, in addition to the general business of the Society, your Council and the Members at large owe a special debt of gratitude. To Mr. William C. Borlase the Council's thanks are due for taking charge of the Secretary's office during Mr. Batten's absence. And they now propose his election to the vacant office.

As Mr. George Bown Millett has tendered to the Council his resignaton of the Curatorship, and as Dr. Clement Le Neve Foster has volunteered to accept the office, the Council request the sanction of the Meeting to the appointment; Mr. G. Bettany, Jun., continuing to act as Assistant Curator. The thanks of the Society are due to Mr. Millett for his past services.

As Mr. E. H. Rodd has again expressed his desire to resign the office of joint Librarian, the Council recommend that his resignation be accepted, fully relying on the continuance of his valuable co-

operation in the general administration of the Society's affairs;—and propose the name of Mr. George Bown Millett as his successor. As ordinary members the names of Mr. W. G. Congdon, Mr. T. W. Field, Mr. S. Chatwood and Capt. D. B. Bedford have during the year been added to the list of Subscribers, and the Annual Meeting are now called on to elect two more, Mr. Francis Gilbert Enys, and Mr. Reginald Paynter, both bearing well known names in Cornwall. The Meeting are also asked to accept the nomination, as a life member, of Dr. C. Le Neve Foster.

In conclusion, as a proof of the continued popularity of the Museum, the Council have much pleasure in stating that nearly 700 names have been recorded in the Visitors' book.

By order

J. H. BATTEN,

Secretary.

17th October, 1873.

LIBRARIAN'S REPORT, 1873.

The first draft of the new Catalogue has been completed and stitched together, and is now available for reference. But this catalogue will not have half its proper value, until the books are first re-arranged and classified, and until each book has a shelf number corresponding with a number in the Catalogue. The present shelves are now greatly crowded—several scores of bound books, and at least a hundred volumes unbound, remaining over. Thus no classification or numbering can be attempted unless a new bookshelf is provided, for which there is ample room.

The binding of the Society's heavy arrears of periodical works becomes very desirable. Among the more important of these works are the Quarterly Journal of the Geological Society, the Proceedings of the Royal Society, the Philosophical Magazine, the Smithsonian Contributions, the Annales des Mines, the publications of the Royal Institution of Cornwall and the Cornwall Polytechnic Society. There is also a considerable accumulation of pamphlets and separate papers, which according to precedent should be bound in Miscellaneous volumes.

There is a deficiency of five volumes (vols. X to XIV) in the Palæontographical Society's Publications, which is a serious obstacle to their usefulness in the arrangement and naming of the fossils. The deficiency of Nos. 62, 63, 67, 70, 72 of the Quarterly Journal of the Geological Society, if not made good, will seriously impair the value of this great standard record of geological research.

The following Presentations have been made to the Museum of this Society since the last Annual Meeting.

Presentations—

1.—A. First Book of Mining and Quarrying.
By J. H. Collins, F.G.S., Author.

2.—Remarques sur les gisements Metalliferès du Cornwall,
By William Jory Henwood, Author.

3.—Monograph of the Fishes of the Old Red Sandstone of Britain. Part I. The Cephalaspidæ.
By E. Ray Lankester, B.A., Author.

4.—Notes and observations on the Gold Fields of Quebec and Nova Scotia, by A. R. C. Selwyn, F.G.S.,

5.—Preface to Catalogue of Cambrian Silurian Fossils in the Geological Museum of Cambridge, by Rev. A. Sedgwick, &c.
Through the Secretary.

6.—Cirque in the Hills of Skye.
By Rev. T. G. Bonney, Author.

7.—Two days in a Mining District.
By W. Whitaker, Esq.

8.—The Fortieth Annual Report of the Royal Cornwall Polytechnic Society.
By the Society.

9.—On the Art of Pottery.
By Joseph Mayer, F.S.A.

10.—Geological Survey of Indiana, 1872.
By E. T. Cox, Author.

11.—Forekonister of Kise, J. Visse, S. Kifere, J. Norge.
By E. B. Münster.

12.—On the Composition and origin of the Waters of a Salt Spring in Seton Mine.
By John Arthur Phillips, Author.

—The Geological Magazine.
By W. J. Henwood.

logischer Atlas Von Island, Von W. Sartorius Von
rshausen.
By the President.

ohlets, Proceedir
Royal Soc

4.—Palæontographical Society's Proceedings.
5.—Proceedings Geologists Association.
6.—Quarterly Journal of the Geological Society.
7.—Proceedings of the American Philosophical Society.
8.—Annual Report Geologists' Association.
9.—Proceedings Geological Society.
10.—Proceedings of Literary and Philosophical Society, Liverpool
11.—Memoirs of the Geological Survey of India.

E. H. RODD, } *Librarians.*
C. C. ROSS , }

October 17th, 1873.

CURATORS' REPORT.—1872-73.

SINCE the last annual meeting, four useful and substantial table-cases have been placed in the Fossil Room, and shelves have been fixed along the north end of the room. These shelves have already received a large number of specimens, consisting of the more bulky fossils and blocks containing fossils, and also of small rock-specimens. These, when all labelled, will be very advantageous for study. The rocks will be much increased in number as the arrangement is completed. Attention may be drawn to the fine series of elephant remains from Norfolk, contributed by Mr. Peach; also to the large blocks of Wenlock limestone and other Silurian rocks, the large Ammonites and sections of Ammonites, &c.

The display of fossils in the cases is not completed. One quarter of the superficial space is devoted to Palœozoic fossils, one quarter to Jurassic, another to Cretaceous and Tertiary, and the remainder to Cornish Fossils. The arrangement of the Palœozoic and Jurassic fossils has made considerable progress, although specimens may be still added from the drawers upstairs. A student can now obtain a tolerable idea of the general aspect and characteristics of the invertebrate life of the older geological periods from these new cases. More especially is this true of the Cambrian fossils, the Coal plants, the Ammonites and Brachiopods of the Jurassic period. It is hoped that the whole of the cases may receive their contents soon after Christmas.

It may be of use to mention some of the formations from which the Society has but scanty collections. Such are the Lower Silurian, all the Cretaceous except the Chalk, and the Tertiaries generally. The friends of the Society would benefit it if they could interest themselves to obtain for the museum any presents which might supply these gaps.

As soon as the invertebrate fossils have been entirely removed from the wall-cases of the upper room, the vertebrate fossils can be re-arranged in those cases, with many important additions from the drawers.

It is in contemplation to examine the mineral collections carefully, to see how far any common or typical specimens are wanting, with a view to the preparation of a list of deficiences, which would very possibly attract the attention of persons able to supply such deficiences.

It may be suggested that the Society cannot consider its work complete unless a small guide-book to the museum is published, making known the general arrangement of the specimens, and drawing attention to the more remarkable of them. This might lead many to derive benefit from a visit to the museum, who now do not carry away any useful idea from their cursory inspection, and might form a commencement of, or an inducement to study, in the case of local residents. A little book of eight pages would probably be sufficient for the purpose, and could be sold at 1d. to visitors.

GEO. BETTANY, Jun.

During the past year the following Presentations have been made to this Society.

By Mr. William West,—

A Stone of Tin found in a large China Clay Lode at the 50 fathoms level at Goonbarrow Mine, St. Austell, and a Stone of Tin taken from a Lode upwards of 20 ft. wide, at the 100 fathoms level at Phœnix Mine.

By Mr. William Oats White, Pendeen,—

Four Specimens of Auriferous Pyrites, from Colorado.

By Mr. Thomas Cornish, Penzance,—

Two Specimens of Spathose Iron, from Perran Lode, Perranzabuloe.

A Specimen of Porphyritic Phonolite, from the Wolf rock, and

A Specimen of Felspathic Granite (China Clay) Stone, from the China Clay Works, Towednack.

By Miss Bessie Connock Collins, Bodmin,—

A Specimen of Foliated Manganese in Trap rock, from a Quarry near Bodmin.

By Mr. Richard Bennetts, Pendeen,

Specimens of Greensand and Shelly Greensand with Jasper, from Haldon Hill, Devon.

By Mr. J. J. Rogers, Penrose,—

Thirty Specimens of Crystalline Limestone, Granite and Trap, from Cintra, Portugal. Collected in 1842.

By Mr. S. H. F. Cox, Penzance,—

A Large Specimen of Oxide of Tin, from the Park of Mines, St. Enoder, near St. Columb.

By Mr. J. Hallet Batten, Heavitree, Exeter,—

Three Specimens of Trap, from Pocombe Quarry, near Exeter.

GEORGE BOWN MILLETT,
GEORGE T. BETTANY, } *Curators.*

TREASURER'S STATEMENT, 1872-3.

RECEIPTS.

	£	s.	d.
Donation H. R. H. The Prince of Wales	20	0	0
Ordinary Subscriptions and Arrears	85	11	0
Donation from late Miss E. T. Carne towards cost of Cases for Fossils ...	20	0	0
Balance due to Treasurer.....	11	7	2
	£136	18	2

EXPENDITURE.

	£	s.	d.
Balance from 1871-2.....	65	2	7
Rates	0	8	0
Housekeeper and Coals	7	7	4
Insurance	2	12	9
Expenses of Secretary and Treasurer	3	18	2
Advertising	2	9	2
Subscription to Palæontographical Society	1	1	0
Life Annuity to Miss E. T. Carne	0	0	0
Printing and Stationery	13	4	2
Sundry Bills	1	15	0
Four Cases for Fossils	39	0	0
	£136	18	2

Wm. BOLITHO, Jun.,

Treasurer.

October 17th, 1873.

LIST OF PAPERS READ AT ANNUAL MEETING.

OCTOBER 17TH, 1873.

1.—Notes on a Section of the Beach near Newlyn, in Mount's Bay, by Mr. T Cornish.

2.—Mr. N. Whitley, gave a brief account of his views on Glacial Action in North Devon.

3.—On some Specimens of Orthoclase, Axinite, Garnets, Actynolite, &c., in the Museum, by Dr. C. Le Neve Foster, F.G.S.

4.—Mr. Robert Tweedy spoke on the subject of Cornish Iron Lodes, with reference to the depreciation in value of Tin and Copper; and was followed on the same subject by the President, Mr. T. S. Bolitho, and Mr. J. H. Collins.

LIST OF THE MEMBERS, OCTOBER, 1873.

Honorary Members.

George James Allman, M.D., F.R.S., late Prof. Nat. Hist. University of Edinburgh, M.R.I.A.

M. L. Elie de Beaumont, Perpetual Secretary of the Institute of France, Paris.

M. Becquerel, Member of the Institute of France, Paris.

Mr. W. H. Benson, Aix la Chapelle.

Henry S. Boase, M.D., F.R.S., F.G.S., &c., Dundee.

M. Ami Boué, M.D., Vienna.

Mr. J. Bowman, London.

James Bryce, M.A., LL.D., F.G.S., &c., Glasgow.

Josiah P. Cooke, Professor of Chemistry, &c., University of Cambridge, United States.

Mr. John F. Cunningham, F.G.S., Liverpool.

M. Achille Delesse, Paris.

Sir Walter Elliot, K.S.I., F.L.S., President Botanical Society, Edinburgh Wolfe Lee, Hawick.

Rev. Thomas England, F.G.S., &c., North Lew, Devon.

William Henry Flower, F.R.S., F.L.S., F.G.S., Conservator Hunterian Museum, London.

Abraham Gesner, M.D., F.G.S., &c., New York.

Sir R. J. Griffith, Bart., LL.D., F.R.S., F.G.S., &c., Dublin.

Mr. Thomas Hawkins, F.G.S., Whitwell, Isle of Wight.

Mr. Sydney Hodges, Torquay.

Mr. Robert Hunt, F.R.S., F.S.S., &c., London.

Mr. John Edward Lee, F.A.S., F.G.S., Caerleon, Monmouth.

Sir Charles Lyell, Bart., D.C.L., LL.D., F,R.S., F.L.S., F.G.S., London.

Mr. Henry McLauchlan, F.G.S., London.

M. Leon Moissenet, Paris.

T. Oldham, LL.D., F.R.S., F.G.S., Calcutta.

Richard Owen, M.D., D.C.L., F.R.S., F.L.S., F.G.S., British Museum, London.

Mr. Joseph Parker, F.G.S., Upton Cheyney, Gloucestershire.
Mr. Charles W. Peach, A.L.S., &c., Edinburgh.
Mr. William Pengelly, F.R.S., F.G.S., Torquay.
John Phillips, LL.D., F.R.S., F.G.S., Oxford.
Lyon Playfair, C.B., M.P., Ph.D., F.R.S., &c., Edinburgh and London.
Mr. Frederick Anthony Potter, F.G.S., Derby and London.
Mr. Joseph Prestwich, F.R.S., F.G.S., &c., London.
M. Constant Prévost, Paris.
Mr. Martyn J. Roberts, F.R.S., Crickhowell, Brecknockshire.
Professor Schœnbein, Basle.
Mr, James Tennant, F.G.S., Professor of Geology, King's College, London.
Major-General G. B. Tremenheere, R.E., late H.M. Bengal Army, F.G.S., London.
Major-General Charles Tremenheere, R.E., C.B., H. M. Bombay Army.
Mr. W. Wagner, President Wagner Institute, &c., Philadelphia, U.S
Mr. Nicholas Whitley, Truro.

Life Members.

Mr. T. Adair Masey, F.G.S., London.
Mr. Warington W. Smyth, F.R.S., F.G.S., &c., London.
Dr. Clement Le Neve Foster, B.A., D.Sc., F.G.S.

Ordinary Members.

Mr. G. L. Basset
,, J. H. Batten, F.R.G.S.
,, G. Bettany
,, Henry Blackwell
,, Francis Boase
,, Edward Bolitho
,, T. S. Bolitho
,, William Bolitho
,, R. F. Bolitho
,, T. Bedford Bolitho
,, T. Robins Bolitho
,, William Bolitho, jun
,, John Borlase
,, Walter Borlase
,, William C. Borlase, F.S.A.
,, Richard Boyns
,, J. R. Branwell
,, F. W. Brittain
,, Thomas Cornish
,, S. F. H. Cox
,, J. Claude Daubuz
Mr. Richard Davey, F.G.S.
,, Joshua Sydney Davey
,, Edward G. Davenport
,, James Dennis
,, John Dennis
,, William Dennis
,, N. B. Downing
,, S. T. G. Downing
,, F. Enys
Viscount Falmouth
Mr. Robert Were Fox, F.R.S.
,, Charles Fox
,, Robert Fox
,, Alfred Lloyd Fox
,, Alfred Fox
,, Charles F. Giesler
,, Henry Grylls
Mrs. Richard Harvey
Mr. C. H. T. Hawkins
Rev. Prebendary Hedgeland, M.A.
Mr. W. J. Henwood, F.R.S.

LIST OF MEMBERS.

Mr. Samuel Higgs
,, Samuel Higgs, jun., F.G.S.
,, Stephen Hill
,, William Husband
,, Stephen Harvey James
,, T. King
,, J. J Lanyon
,, Edward Lavin
,, Day P. Le Grice, M.A.
,, Martin Magor
Rev. J. H. Marshall
Mr. A. H. Michell
,, G. B. Millett
,, J. P. Milton
,, William Michell
Earl of Mount Edgcumbe
Mr. S. R. Pattison, F.G.S.
,, H. Paull
,, R. Paynter
,, R. Pearce, F.G.S.
Rev. M. N. Peters, M.A.
Mr. T. Roxburgh Polwhele, M.A., F.G.S.
,, E. Hearle Rodd
,, W. H. Rodd
,, J. Jope Rogers
,, John Roscorla
,, C. Campbell Ross
Sir Edward St. Aubyn, Bart
Mr. John St. Aubyn, M.P.
Rev. Edmund St. Aubyn
Earl of St. Germans, G.C.B.
Sir Edward Smirke
Mr. Bickford Smith
Rev. F. Stephens
Mr. John Symons
,, Richard Taylor, F.G.S.
Mr. William Teague
,, J. Vosper Thomas
Rev. J. Tonkin
Colonel A. Tremayne
Mr. H. S. Tremenheere, C.B., M.A. F.G.S.
Col. H. R. Trelawny
Mr. William Trythall
,, Robert Tweedy
,, A. P. Vivian, M.P.
Sir Richard R. Vyvyan, Bart. F.R.S., F.G.S.
Mr. N. J. West
,, William West, C.E.
Sir Frederick M. Williams, Bart., M.P., F.G.S.
Mr. J. Michael Williams
,, George Williams

Associates.

Mr. Arundel Anthony, Lelant
,, Richard Bain, Burncoose
,, Francis Barratt, St. Austell
,, James Bennetts, St. Just
,, Thomas Blamey, Gwennap
,, J. T. Blight, F.S.A., Penzance
,, Charles Chorley, Truro
,, J. H. Collins, F.G.S., Falmouth
,, William Eddy, Pendeen Consols Mine, St. Just
,, James Evans, Illogan
,, John Giles, Sheffield
,, William Gregor, Swansea
,, R. T. Hall, (Devoran), Africa
,, William Hollow, Lelant
,, W. F. Hooper, Truro
,, Richard James, St. Ives
Mr. S. Michell, Swansea
,, John Nancarrow, Camborne
,, Richard Newton, St. Agnes
,, Francis Oats, St. Just
,, Henry Pascoe, Berehaven Mines Co. Cork
,, John Phillips, Australia
,, W. Provis, Dolcoath
,, John Rowe, Botallack, St. Just
,, Stephen Thomas, Redruth
,, Tho. Treloar, (Brazil,), London
,, Thomas Trezise, Redruth
,, Thomas Treweeke, St. Ives
,, Joseph Vivian, Camborne
,, William Vivian, Mwyndy, Glamorganshire
,, John Way, Gwennap

2 G2
.C8
A2

Royal Geological Society of Cornwall.

Journ. V. 9

THE SIXTY-THIRD

ANNUAL REPORT

OF THE COUNCIL,

WITH THE PRESIDENT'S ADDRESS,

AND

TREASURER'S AND LIBRARIAN'S REPORTS,

ETC. ETC.

PLYMOUTH:
W. BRENDON & SON, 26, GEORGE STREET.

1877.

Royal Geological Society of Cornwall.

THE SIXTY-THIRD

ANNUAL REPORT,

ETC. ETC.

PENZANCE.
1877.

QE
363
.C5
A2

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Patroness:
HER MOST GRACIOUS MAJESTY THE QUEEN.

Vice-Patron:
HIS ROYAL HIGHNESS THE PRINCE OF WALES, K.G., ETC.

Trustees:
T. S. BOLITHO, Esq. D. P. LE GRICE, Esq., M.A.
COLONEL TREMAYNE.

OFFICERS AND COUNCIL FOR 1876–7.

President:
WARINGTON W. SMYTH, Esq., M.A., F.R.S.

Vice-Presidents:
THE EARL OF MOUNT EDGCUMBE. GUSTAVUS LAMBART BASSET, Esq.
SIR JOHN ST. AUBYN, Bart, M.P. THE REV. PREB. HEDGELAND, M.A.

Treasurer:
WILLIAM BOLITHO, Jun., Esq.

Secretary:
GEORGE BOWN MILLETT, Esq., M.R.C.S.

Librarian:
CHARLES CAMPBELL ROSS, Esq.

Curator:
CLEMENT LE NEVE FOSTER, Esq., B.A., D.SC., F.G.S.

Assistant-Curator:
ANDREW K. BARNETT, Esq., F.G.S.

Council:
THE OFFICERS OF THE SOCIETY.

SIR F. M. WILLIAMS, Bart, M.P.
F. G. ENYS, Esq.
ALFRED LLOYD FOX, Esq.
T. ROXBURGH POLWHELE, Esq., M.A.
T. ROBINS BOLITHO, Esq.
WILLIAM C. BORLASE, Esq., B.A., F.S.A.
H. S. TREMENHEERE, Esq., C.B., M.A.
CLEMENT LE NEVE FOSTER, Esq., D.SC.
THOMAS CORNISH, Esq.
D. P. LE GRICE, Esq., M.A.
JONATHAN RASHLEIGH, Esq.
A. P. VIVIAN, Esq., M.P.

LIST OF MEMBERS.

Honorary Members.

George James Allman, M.D., F.R.S., President of the Linnæan Society, M.R.I.A.

Antoine César Becquerel, Member of the Institute of France, Paris.

W. H. Benson, Aix-la-Chapelle.

Henry S. Boase, M.D., F.R.S., F.G.S., etc., Seafield House, Magdalen Road, Dundee.

Ami Boué, M.D., Vienna.

J. Bowman, London.

James Bryce, M.A., LL.D., F.G.S., etc., High School, Glasgow, and Bowes Hill, Blantyre, Lanarkshire.

Josiah P. Cooke, Professor of Chemistry, etc., University of Cambridge, United States.

Bernhard von Cotta, formerly Professor of Geology in the Freiberg School of Mines, Saxony.

John F. Cunningham, F.G.S., 5, Fenwick Street, Liverpool.

James Dwight Dana, LL.D., M.A., Professor of Geology, Yale College, etc., Newhaven, United States.

Auguste Daubrée, Member of the Institute of France, etc., Paris.

Heinrich von Dechen, Oberberghauptmann, etc., Bonn, Germany.

Achille Delesse, Professeur à l'Ecole des Mines, Paris.

Sir Walter Elliot, K.S.I., F.L.S., President Botanical Society, Edinburgh, etc., Wolfe Lee, Hawick.

Rev. Thomas England, F.G.S., etc., North Lew, Devon.

William Henry Flower, F.R.S., F.L.S., F.G.S., Hunterian Professor of Comparative Anatomy, and Conservator of the Museum, Royal College of Surgeons, London.

David Forbes, F.R.S., Sec. G.S., F.C.S., London.

Sir R. J. Griffith, Bart., LL.D., F.R.S., F.G.S., etc., 2, Fitzwilliam Place, Dublin.

Thomas Hawkins, F.G.S.

Sydney Hodges, Torquay.

Robert Hunt, F.R.S., F.S.S., etc., Keeper of Mining Records, 28, Jermyn Street, S.W., and 26, St. Leonards Terrace, Chelsea, S.W., London.
John Edward Lee, F.A.S., F.G.S., Villa Syracusa, Torquay.
Henry McLauchlan, F.G.S., 14, Liston Road, Clapham, London, S.W.
Léon Moissenet, Ecole des Mines, Paris.
T. Oldham, LL.D., F.R.S., F.G.S., Director of the Geological Survey of India, 1, Hastings Street, Calcutta.
Richard Owen, M.D., D.C.L., F.R.S., F.L.S., F.G.S., British Museum, London, Sheen Lodge, Richmond, Surrey.
Joseph Parker, F.G.S., Upton Cheyney, Bitton, near Bristol.
Charles W. Peach, A.L.S., etc., Edinburgh.
William Pengelly, F.R.S., F.G.S., Lamorna, Torquay.
Lyon Playfair, C.B., M.P., Ph.D., F.R.S., etc., Edinburgh and London.
Frederick Anthony Potter, F.G.S., Takasima Colliery, near Nagasaki, Japan, and 88, Tower Hill, London, E.C.
Joseph Prestwich, M.A., F.R.S., F.G.S., etc., Professor of Geology, Oxford, Darent Hulme, near Shoreham, Sevenoaks.
Martyn J. Roberts, F.R.S., Crickhowell, Brecknockshire.
Bernhard M. Studer, Professor of Geology, Berne.
James Tennant, F.G.S., Professor of Mineralogy, King's College, London, 149, Strand. W.C.
Major-General G. B. Tremenheere, R.E., late H.M. Bengal Army, F.G.S., Spring Grove, Isleworth, London.
Major-General Charles Tremenheere, R.E., C.B., H.M. Bombay Army.
W. Wagner, President Wagner Institute, etc., Philadelphia. U.S.
Nicholas Whitley, Truro.

Life Members.

Clement Le Neve Foster, B.A., D.Sc., F.G.S., Truro.
Thomas Adair Masey, F.G.S., 6, Crown Office Row, Temple, London, W.C., and North Cheam, Surrey.
The Earl of St. Germans, G.C.B., Port Elliot, St. Germans.
Warington W. Smyth, M.A., F.R.S., F.G.S., and Foreign Secretary, Chief Inspector of Crown Mines, etc., Museum, Jermyn Street, S.W., and 5, Inverness Terrace, London, W., and Marazion.

Ordinary Members.

Gustavus Lambart Basset, Tehidy, Camborne.
John Hallet Batten, F.R.G.S., 5, Manston Terrace, Heavitree, Exeter.
Captain Bedford, R.N., Penzance.
Henry Blackwell, Penzance.
Francis Boase, M.R.C.S., Penzance.

Edward Bolitho, Trewidden, Penzance.
Thomas Simon Bolitho, Trengwainton, Penzance.
William Bolitho, Polwithen, Penzance.
Richard Foster Bolitho, Ponsandane, Penzance.
Thomas Bedford Bolitho, Trewidden, Penzance.
Thomas Robins Bolitho, Pendrea, Penzance.
William Bolitho, jun., Ponsandane, Penzance.
John Borlase, Castle Horneck, Penzance.
William Copeland Borlase, B.A., F.S.A., Castle Horneck, Penzance.
Richard Boyns, St. Just.
John Richards Branwell, Penlee, Penzance.
Frederick W. Brittain, Lanoweth House, Penzance.
Thomas Cornish, Penzance.
Rev. Thomas Borlase Coulson, M.A., Buryan, Penzance.
Samuel Henry Fortnon Cox, Lower Carloggos, St. Columb.
John Claude Daubuz, Killiow, Truro.
Richard Davey, F.G.S., Redruth.
Joshua Sydney Davey, Bochym, Helston.
James Dennis, Penzance.
John Dennis, Lower Lariggan, Penzance.
William Dennis, Penzance.
Samuel Theophilus Genn Downing, Redruth.
Francis Gilbert Enys, Enys, Penryn.
The Viscount Falmouth, Tregothnan, Falmouth.
Thomas William Field, Chymorvah, Marazion.
Robert Were Fox, F.R.S., Penjerrick, Falmouth.
Charles Fox, Trebah, Falmouth.
Robert Fox, Falmouth.
Alfred Lloyd Fox, Falmouth.
Charles F. Giesler, 21, Saville Row, London.
Carew Davies Gilbert, Trelissick, Truro.
Henry Grylls, Morton House, Redruth.
Francis Macfarlane Harvey, Glanmôr, Hayle.
Mrs. Richard Harvey, Greenway, Dartmouth.
Christopher H. T. Hawkins, Trewithen, Probus.
Rev. Prebendary Hedgeland, M.A., Penzance.
Samuel Higgs, F.G.S., Wallaroo, Australia.
William Husband, M. Inst. C.E., Hayle.
Stephen Harvey James, St. Just.
Thomas King, M.A., Penzance.
Joseph James Lanyon, Penzance.
Day Perry Le Grice, M.A., Trereife, Penzance.
George Welland Mackenzie, 15, Hans Place, London. S.W.
Martin Magor, Penzance.

Andrew Harpur Michell, Penzance.
George Bown Millett, M.R.C.S., Penzance.
John Penn Milton, Penzance.
James Barclay Montgomery, M.D., F.R.C.P., Penzance.
The Earl of Mount Edgcumbe, Mount Edgcumbe, Plymouth.
Richard Pearce, F.G.S., Golden City, Colorado.
William Cole Pendarves, Pendarves, Camborne.
Rev. Michael Nowell Peters, M.A., Penzance.
Walter Pike, Camborne.
Thomas Roxburgh Polwhele, M.A., F.G.S., Polwhele, Truro.
Jonathan Rashleigh, Menabilly, Fowey.
Edward Hearle Rodd, Penzance.
William Henry Rodd, Penzance.
John Jope Rogers, Penrose, Helston.
John Roscorla, Penzance.
Charles Campbell Ross, Penzance.
Joseph Carne Ross, F.G.S., 12, Chalmers Street, Lawriston, Edinburgh.
Sir John St. Aubyn, Bart., M.P., St. Michael's Mount, and Trevethoe, Lelant.
Rev. St. Aubyn Molesworth St. Aubyn, Clowance, Camborne.
Bickford Smith, Redbrook, Camborne.
George John Smith, Trevu, Camborne.
John Symons, Mayon House, Sennen.
Richard Taylor, F.G.S., 6, Queen Street Place, Upper Thames Street, London.
William Teague, Trelisk, Truro.
William Teague, jun., Pool.
Josiah Thomas, Dolcoath, Camborne.
Rev. John Tonkin, Treverven, Buryan, near Penzance.
Colonel Arthur Tremayne, Carclew, Penryn.
Hugh Seymour Tremenheere, C.B., M.A., F.G.S., 43, Thurloe Square, Brompton, London. S.W.
William Trythall, Penzance.
Robert Tweedy, Tregolls, Truro.
Charles Twite, F.R.G.S., F.G.S., 5, Victoria Street, Westminster, S.W., and St. Agnes, Cornwall.
Alfred Tylor, F.G.S., Carshalton, Surrey.
Arthur Pendarves Vivian, M.P., Glan Afon, Taibach, South Wales.
Sir Richard Rawlinson Vyvyan, Bart., F.R.S., F.G.S., Trelowarren, Helston.
Nicholas J. West, Hayle.
John Westlake, Q.C., 16, Oxford Square, London. W.
Sir Frederick Martin Williams, Bart., M.P., F.G.S., Goonvrea, Truro.
John Michael Williams, Carhayes Castle, St. Austell.
George Williams, Scorrier.

ASSOCIATES.

Arundel Anthony, Lelant.
James Bennetts, St. Just.
J. T. Blight, F.S.A., Penzance.
J. H. Collins, F.G.S., Truro.
William Eddy, Pendeen Consols Mine, St. Just.
James Evans, Illogan.
John Giles, Sheffield.
William Gregor, Swansea.
R. T. Hall, Cape Copper Mines, Africa.
William Hollow, Lelant.
W. F. Hooper, Truro.
Richard James, St. Ives.
Benedict Kitto, F.G.S., Redruth.
John Maynard, East Pool Mine, Camborne.
S. Michell, Swansea.
John Nancarrow, Camborne.
Francis Oats, F.G.S., St. Just, Penzance.
John Phillips, Australia.
T. B. Provis, Camborne.
John Rowe, Botallack, St. Just.
Stephen Thomas, Redruth.
Thomas Treloar, London.
Thomas Treweeke, St. Ives.
Joseph Vivian, Camborne.
William Vivian, Mwyndy, Glamorganshire.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

THERE are some occasions on which, although we may have other grounds for satisfaction and gratitude, we are nevertheless oppressed by the weight of a heavy misfortune, and cannot but fix our attention almost exclusively on the loss sustained.

On the present occasion I cannot refrain from dwelling in the first instance upon what, both in private circles and before the public, must be accounted a serious calamity. The Geological Society of Cornwall has in the past year lost its brightest ornament. The death of Robert Were Fox, at the ripe age of eighty-eight years, has robbed us of a philanthropist and experimental philosopher, who was an honour not alone to Cornwall, but to his country at large. And to us here assembled for our annual meeting there is special matter for reflection—a peculiar suggestion of solemnity in the fact that by the decease of Mr. Fox we have lost, as it would appear, the last survivor of the original members of the Society. It was in 1814 that, under the lead of Davies Gilbert and Dr. Paris, a small band of active-minded friends of science founded this, the first among local associations devoted to the advancement of geological knowledge. This spirited step was taken only seven years after the launch of the parent Society in London; sixty-three years have passed away, and the last of the pioneers is swept into the grave.

There would be something very dispiriting about such a loss had we not on all sides the lesson read to us by Nature, independently of other and higher considerations, that there must necessarily be a constant change, and that out of age and decay may be expected to arise the seeds of youth and strength, and the hope of improvement and progress. It cannot but invigorate the mind, and light up a bright example, to look back upon the long career of

usefulness of our departed friend, to note the decided emphasis with which both in experimenting and in writing he made his mark in the world, and to be assured that the impulse which he has given must long survive his mere years of mundane life.

The first volumes of the Transactions testify to the industry of his early years; but it would appear that long before their publication he had as a youth taken up the study of sundry branches of the natural sciences. His mother is said to have directed his attention to the properties of steam, and one of the first subjects of his enquiry was that so closely associated with the welfare of Cornish mines, the limit of the advantages of high-pressure steam. In 1812 he joined his friend Mr. Joel Lean, then of Budock, in taking out a patent for improvements in steam-engines. Soon after this he was led into an enquiry of a newer character, which he worked so well as to establish thereby his reputation throughout Europe. He brought up evidence *de profundis*, as his brother, your former president, Mr. Charles Fox, puts it, "that mother earth retained in her bosom warmth more genial than volcanic fire, and an electro-magnetic *vis insita* which plays amidst her strata, and amidst the flashes of the aurora, and is doubtless connected with the crystallisation and arrangement of her minerals."

Mr. Fox's first communications on the subject of the temperature of the earth's crust were read before this Society in 1819 and 1820,* his attention having been first drawn to the matter by Mr. Joel Lean about 1815. Very modestly in his first paper he suggests that "the fact of a great degree of warmth being experienced in mines at considerable depths below the surface does not appear to have attracted so much notice as it probably deserves." The mean result from his table of observations, showing an increase of 5° Fahrenheit for a depth of 300 feet, or 1° Fahrenheit for 60 feet, is so near to what may be taken as the average given by many observers in different parts of the world, as to impress one with the importance of such a contribution to science at a time when not only had "public opinion" a great objection to these views, but certain insufficiently-practised experts joined in decrying them,

* "Trans. Royal Geological Society of Cornwall," vol. ii. p. 14.

and Mr. Moyle read to you in 1822 his observations, and his conclusion drawn from them, that "the doctrine of the progressive increase of heat in proportion to the depth is without foundation." *

Even the great and liberally-minded Arago is stated to have evinced a strong disinclination to adopt Mr. Fox's views, although they were so strikingly to be verified, only a few years later, by examination of the temperature of the water in Artesian wells, and particularly by that of the successful boring of Grenelle, to the progress of which the French Academy had devoted close attention, and where the water, rushing from the depth of 300 fathoms to the surface, had exactly the temperature which had been predicted for it.

"Without entering," wrote Mr. Fox, "into speculation on the exciting cause, or on the extent of the internal heat, it is probable that the ascent of warm vapour may produce the high temperature in mines; and that its effect is more or less considerable in proportion to the facility with which it finds a passage upwards." It was hence to be expected that great variations, and sometimes even anomalies, would occur in the rate of increase of heat in descending; but the continued labours of Mr. Fox, carried on over many years, published in all the scientific transactions and magazines, and ably seconded by W. J. Henwood, Professor Phillips, Professor Reich, of Freiberg, and others, thoroughly established the general fact. The interior heat may now be almost wholly masked and stifled by the non-conducting stratified masses which form the crust of the earth; but it must formerly have influenced in a decided manner the temperature, and with it all other phenomena, at the surface.

Somewhat later, towards the year 1830,† and thence onward for several years, Mr. Fox took up enthusiastically the subject of electro-magnetism, and particularly the development of such forces in the various rock masses, and in mineral veins. He was even impressed with the belief that these forces might not only "contribute to produce the extraordinary aggregation and position of

* *Ibid*, vol. ii. p. 404.

† "Philosophical Trans.," 1830, and "Trans. Geol. Soc. of Cornwall," vol. iv. 1832; also "Geol. Soc. Proceedings," ii. and iii. 1838 and 1842.

homogeneous minerals in veins; but also that a similar action is still at work in them; and further, that observations made with suitable instruments might be available for the discovery of underground bodies of ore. Many ingenious experiments, attended by pretty results, were brought out in the course of these electro-chemical enquiries, and it is claimed for him that he was the first person in England to discover that the electro-magnetic circuit is completed by the earth, and hence that a single telegraphic wire sufficed for action. M. Ampère inferred, from the conclusions brought out by Oersted, that the direction of the terrestrial magnetic meridian is due to electrical currents circulating from east to west round the globe. Mr. Fox, anxious to throw light on the filling of our lodes, argued that such currents would tend to course through east and west fissures, in which saline solutions were present. Hence would arise a gradual decomposition of the saline substances, when the metals or bases would be determined towards the electro-negative contiguous rocks, and the acids to the electro-positive.

The variations in intensity of the earth's magnetism, and the dip and declination of the needle, were subjects of delight and constant attention to our late associate. His construction of the deflector dipping needle, and the numerous observations which he published upon it, made him the trusted adviser of the Admiralty, and of naval and military officers starting on exploring expeditions; and even in his advanced age he was glad to aid in the preparation of the instruments for the late polar voyage under Sir George Nares.

To go fully into the works and merits of Robert Were Fox would carry me far beyond the limits of an address, and I believe they are to be brought before the public by an author resident near us. The list of his publications amounts to nearly sixty, and many of them have been translated into foreign languages.

With a good knowledge of chemistry, and a general love of natural history, Mr. Fox was particularly notable as a mineralogist. Not one who contemplated a mineral as a dry and dead subject of chemical or of geometrical disquisition, but who took it as a centre of various interests, coupled with questions of physics, of statistics, of geography, and even of personal character. Nowhere do I

recollect to have passed more charming hours than in hearing his elucidation of a drawer or two of mineral specimens from his choice little cabinet at Penjerrick.

Of Mr. Fox's benevolence and private virtues this is not the place to speak. A very large circle of admiring friends knows full well what he was; and no one who was admitted to that circle, and calls to mind that beaming and intellectual face, will fail to admit that his death has left a void not likely to be filled.

The Society has lost also during the year the Earl of St. Germans, who has acted as one of your Vice-Presidents, and Mr. J. Dennis, who was serving on your Council. It has likewise to regret the death of Mr. Symons, of Sennen, and Mr. Giesler, of London, among the ordinary members.

The honorary list is also deprived of two of its names, Dr. Bryce, of Glasgow, author of several papers on divers subjects in Scottish geology, and Mr. David Forbes, F.R.S., of whom I had hoped that he would become one of the lights on certain Cornish subjects. My late friend was a younger brother of the late well-known naturalist, Professor Edward Forbes, but took up the line of chemical and metallurgical study under Dr. George Wilson and Dr. Percy. He was fortunate enough to be appointed by Messrs. Evans and Askin, of Birmingham, to a post in Norway, where for above eleven years he had a fine field for his energetic studies, chemical, mineralogical, and geological. Thence he went to South America, on a roving commission, which kept him for years in Peru, Chili, and the Sandwich Islands. Very laborious, bold in action, a good linguist, systematic almost to a fault, Forbes acquired a vast amount of knowledge; his notes, his books, and collections increased in like degree. Of late years his gratuitous work as Secretary to the Geological Society, and to the Steel and Iron Institute, was never-ending; his employment as an adviser on mining and smelting matters very harassing. Ill health attacked him, but he refused to give way; and at length, in December last, this able man, insisting almost to the last on continuing his labours, was untimely carried off, in his forty-ninth year, to the great regret of those who knew the good work that might have been expected of him.

Let me now request the attention of the Society to certain ques-

tions which affect its Museum. The zeal and liberality of our members, aided by the public spirit of the Corporation of Penzance, have given us a "local habitation" of which all the contributing parties may well be proud; and a good name has in an eminent degree been handed down by our predecessors. Their useful work has been in part literary, but has also notably consisted in bringing together collections, which should be no less illustrative of observations made than of the progress of general science. In one division of this department, viz., in that of mineralogy, a very forward step was taken several years ago, when the new cabinets were enabled, by the industry and intelligence of the Misses Carne, to exhibit a series of minerals illustrative not only of this county, but of the world at large. In the meanwhile your Council and your President have been obliged from time to time to admit that with the collections of stratigraphical geology, with the fossils which should illustrate the history of life on the globe, equal progress was not made. Certain collections, especially that of Mr. Peach, had been very judiciously purchased, whilst others, mostly in small groups, had been presented by members who happened to visit fossiliferous localities. But no consistent efforts were made to bring together such a series as should be scientifically complete; and a difficulty was found in inducing a competent person to undertake the naming and arrangement of the objects already in the drawers of the Museum. Hence year after year the Reports brought before your annual meetings have had to express regrets and explanations for the backwardness of the organic as compared with the inorganic division of your treasures. My excellent predecessor, Mr. Tremenheere, informed us in 1869 how he had consulted Mr. Etheridge, F.R.S., so well known to the scientific world, not only for his important contributions to palæontology, but for his admirable museum work at Bristol and at Jermyn Street, and he gave us at that time a sketch-plan of arrangement. Two years later Mr. Bettany, jun., devoted his gratuitous services for a long period of time to making the commencement of a satisfactory grouping and ordering of these collections. At length, this last summer, Mr. Etheridge has been induced to visit Penzance, and has devoted ten days' close work to examining, and partly arranging and naming the specimens, under

two heads of division. The first of these ought to be a general series of fossils, from the earliest periods to the most recent, stratigraphically grouped, thus giving to the visitor a distinct *conspectus* of the succession of life in time, and therein presenting a standard and proof of the reasoning as to formations, lapse of time, changes of climate, and other conclusions urged by geologists. Unfortunately the hap-hazard way in which these objects have been acquired is incompatible with completeness, and your Curator's Report will state how Mr. Etheridge condemns this part of the collection as being utterly inefficient for educational purposes, and how he suggests that a moderate sum should be expended in obtaining a few hundred typical species, the selection of which he would kindly superintend; which then, extended through the present wall-case and another to be placed on the eastern side of the fossil-room, would bring this department of your Museum abreast of the present position of the science. Thus the Society, which has always recognized among its objects the furtherance of scientific education, would supply to lovers of geology an opportunity and means, hitherto wanting in the West of England, of studying one of the most important pages in the book of nature.

The story of the second division of your fossil-room is an entirely different one. Here you possess the fullest illustrations in existence of the life of the area of Cornwall in the oldest periods. Here it is therefore that men who would endeavour to extend the bounds of knowledge must study the examples which have been extracted from the Cornish strata by the acute observation and patient assiduity of a few local explorers. Here again it is that you may expect enquirers into difficult questions on the remote history of the pre-Carboniferous times to come to visit you from all parts of the world, to compare the relics of the ancient life of these strata with those of large regions in Europe, America, and Australia.

Let me remind you that for many years after the first foundation of this Society there was not an idea that any such subject of enquiry existed in the great bulk of the Cornish strata. It was said by Pryce, "We have no exuviæ of land or sea animals buried in our strata;" and the killas was, long after the time of that writer, regarded as primitive, primary, or non-fossiliferous grey-

wacke. The labours of the Rev. R. Hennah, Mr. Weaver, and Mr. Godwin-Austen, in the neighbouring parts of South Devon, were followed up by Col. Harding and the Rev. D. Williams in North Devon, and in East Cornwall by the philosophical Dean Conybeare and Mr. Pattison, formerly of Launceston, and afterwards by Professors Phillips, Sedgwick, and Murchison, and Mr. C. Peach, then stationed at Gorran Haven. And from these it resulted that the north-eastern district, from Launceston away to Bideford Bay, is occupied by a wide and contorted trough of Carboniferous strata; and that all the southern portion, excepting a small tract adjoining Veryan Bay, might be considered as belonging to a lower system or formation, to which, owing to its clear development in the adjoining county, the name "Devonian" was applied.

Various propositions have been made by the above, and by subsequent authors who have followed up the examination of those districts, to establish such sub-divisions of the "system" as should facilitate, on the one hand, the study of the stratigraphical structure of the county, and on the other the comprehension of the succession of animal life in its former seas. But in this point of view, and especially for the central and western parts of Cornwall, the subject is still beset with difficulty, and in the solution of its questions the specimens which we are now discussing will play a prominent part.

The words which were addressed to the very first meeting of this Society, in 1814, by the Rev. C. V. Le Grice, as an incentive to study the inorganic, are still applicable in encouraging work in the organic branch of the natural history of the Cornish strata: "Were we to indulge the imagination by personifying the science, we should surely assign to the genius of geology this spot as her local habitation—her most favoured abode. The grandeur of our rocks, the chasms of our mines, the soil on which we tread, replete with wonders—*concavæ speluncarum altitudines, saxorum asperitates, infinitaque vis marmoris*—form, as it were, a theatre in which geology displays all her powers, and we are invited and roused to emulation in the science by the genius of the place."

Mindful of the spirited allocution of one of your founders, I shall venture to constitute myself advocate for those oldest examples

of the Cornish race which are enclosed in the cases of the lower room, and which, I fear, from their dull grey or snuffy-brown suits, and general indistinctness, are not wont to meet with the respect which they merit. With the assistance therefore of my friend Mr. Etheridge, I will enlarge somewhat on the character of this collection.

The organic remains of the Devonian rocks of Cornwall, with some from the middle division of that group, at Torquay and Newton Bushel, &c., are finely represented in our museum; indeed, so far as those of Cornwall are concerned, they are unequalled both in number of species and perfection of condition, being scarcely surpassed by the fine and typical forms of Rhenish Prussia and Belgium, and from beds of the same age; indeed the fossils of the Eifel limestone, and Calceola-schiefer of the middle group, and the Ardennes-schiefer, Coblentz-schiefer, Wissenbach slates and spirifer sandstone of the Lower Devonian of the Rhenish area, are nearly all represented, if not occurring as identical species with those of the lower and middle group of Cornwall.

Our collection contains Devonian forms from the lower, middle, and upper series, in most of those areas in the counties of Cornwall and Devon where the rocks are exposed. It must be allowed that it is essential to the credit and future history of the Society that this of all groups of rocks and associated fossils should be well, if not perfectly, represented in the museum. The collection as it now stands is in the main due to the energy and industry of Mr. Charles Peach, A.L.S., one of our oldest living naturalists, who for many years resided on the south coast of Cornwall, there making a special study of the coast sections, and who extensively collected from them, especially at East and West Looe, Polperro, Polruan, and Fowey. This truly great collection is now displayed in the cases of our Society, and has been but little added to since, a circumstance especially to be regretted, when we take into consideration the great amount of work and research that has been done and carried on in Russia, America, the Rhenish, Belgian, and French areas, Spain, and Australia.

The labours of De la Beche, Phillips, Murchison, Sedgwick, Salter, Hall, Pengelly, and Etheridge are known and conspicuous

in Britain; Logan and Dawson in Canada; Hall, Haydon, Meek, and Worthen in America; Von Dechen, Sandberger, Römer, &c. in Rhenish Prussia; Gosselet in France; De Koninck and Etheridge in Australian researches. All these writers, both on palæontological and physical grounds, have successfully laboured to show and prove the importance of the great Devonian "system," or series of marine deposits, having a special fauna, existing between the Upper Silurian and the base of the Carboniferous rocks. Whether the true *Old Red* Sandstones of Scotland, Herefordshire, and South Wales are of the same age is a question, and matter yet for solution. Stratigraphically the Old Red Sandstone may be, and probably is, older than, or placed geographically below, the marine Devonian. Nowhere, however, can this be so clearly determined as in North Devon and West Somerset, where the type of Old Red Sandstone is developed, and its strata underlie the true Devonian rocks, but are devoid of all fossil evidence. These red sandstones occur at the Quantock Hills, Minehead, Porlock, and the Foreland, and are not known under the same condition or aspect south of that district; in other words, this Devonian type of the "Old Red" is unknown in Cornwall south of Tintagel, or through the country striking along from thence to the northern slopes of the Dartmoor, round to Torquay, Newton, &c. South of this line the sedimentary rocks are all of Lower and Middle Devonian age.*

To the above list of authors I must add the name of an old friend and colleague, the late Professor Jukes, whose previous work in Ireland induced him to adopt peculiar views as to the schistose strata of Devon and Cornwall; and so important would this dissent be if only well-founded, that it may be well to see in what way it would affect the adjoining county, and through it the conclusions to be formed as to the Cornish formations.

In 1864 Mr. Jukes, at that time Director of the Geological Survey of Ireland, gave a concise description of the rocks comprising the Old Red Sandstone and Carboniferous beds of South Ireland, which led him to embody certain conclusions relative to

* The only exception being Start Point and Bolt Head, south of Dartmouth, and Veryan Bay, south of St. Austell, which are Lower Silurian.

these two formations in a paper on North Devon and Rhenish Prussia. In 1865 he again briefly described the Irish beds, and entered into the question of the contemporaneity of the Carboniferous slate and Carboniferous limestone, introducing some of the North Devon strata into the question. In 1866 he again drew a comparison between the so-called "Carboniferous slates" of the South of Ireland, and the Devonian of North Devon, propounding views which differed much from those of the older authors, and which would tend to remove the Devonian series as a system altogether from the British rocks. In 1867, in a pamphlet supplying certain deficiencies in his previous communication to the Geological Society, the rocks below the so-called Upper Old Red Sandstone of Pickwell Down, and other parts of North Devon, were again partly described. His views being quite at variance with those of preceding authors, and giving rise to much discussion, a re-examination of North Devon was undertaken, both on physical and palæontological grounds, by Mr. Etheridge, at the request of Sir R. Murchison.

Mr. Jukes held the opinion that the whole of the slates and limestones above the Foreland at Linton, Ilfracombe, Morte, &c., to the overlying Carboniferous series at Barnstaple, and to the south of it, could be correlated and paralleled with the "Coomhola" slates of the South of Ireland; and if the Irish beds are "Carboniferous," and the North Devon the same, then, according to Jukes, there is no Devonian system in North Devon. But this hypothesis did not bear the close scrutiny given to it by others. The horizons of the Linton, Ilfracombe, and Baggy Point beds are definitely understood; and they possess a fauna Eifelian and Coblentzian in character, agreeing, in fact, with the great Rhenish deposits, the age of which no one disputes.

Again Mr. Jukes proposed or assumed a hypothetical fault at Morte Bay, below the Pickwell Down sandstone, and stated that the Linton and Ilfracombe beds were here repeated. This fault, according to other observers, has no existence; and the true Upper Devonian fauna rests upon the Pickwell Down sandstone, which in its turn rests upon the unfossiliferous Mortehoe slates, and they upon the middle calcareous series of Ilfracombe and Combe

Martin, succeeded below by the Linton slates, in which are a few fossil fish.

In South Devon no Upper Devonian rocks are known, the Middle series being covered by the Carboniferous; whether unconformably or not it is difficult to say.

When physical facts and fossil evidence can be put forward, showing that the Linton and Ilfracombe series are *not* below the Pickwell Down beds, and are not Lower and Middle Devonian, then perhaps may some new reading be propounded for the geological structure of North Devon. Let the Devonian system be equated to what it may, it is nevertheless, in the opinion of palæontologists, a great life-group—a system based upon clear stratigraphical succession of strata, and an associated and well-marked marine fauna, borne out and testified to by its extended and equivalent groups in various parts of Europe, paralleled in America, and determined to be the same as those of Australia; at the same time that they are different in most, if not all, respects from the succeeding Carboniferous.

The true history of the Cornish Devonian rocks has yet to be written; for west of Plymouth and south of Tintagel no divisional interlineation or true sequence has been clearly made out. In other words, the well-recognised time horizons or life-groups, so well understood in Rhenish Prussia, Belgium, and France, and also in North Devon, have not been carried out in detail in Cornwall: it has yet to be done.

The abundant Devonian material existing in our museum cases at once furnishes *data* for establishing a true succession and correlation, based upon the distribution of its organic contents; for in no other way can these slaty rocks be co-ordinated either with the Eifelian, Coblentzian, or the French beds; and it is to the two former of these groups we must look for the true reading of the Cornish Devonian deposits. The South of Ireland affords us no assistance; the difficulty arising from the nature of the rocks and the paucity of organic remains in their so-called Old Red Sandstone.

The Middle Devonian group is well developed in North and South Devon, and Cornwall, both physically and palæontologically, and is paralleled in every particular in the three well-known Con-

tinental areas, where, as with us, they constitute an upward and ascending succession into the Upper Devonian series, and thence into the Carboniferous; and it will be found on strict examination, when worked out, that the geological age of the Cornish fossils will be proved and determined by the stratigraphical position of the beds containing them, and the order of succession in Cornwall will be found to be in accordance with those of other parts of Europe, the zoological evidence being complete.

It is impossible to examine the distinctive fauna of the Cornish Devonian rocks, taken collectively and compared with the type Continental equivalents, where the sequence is clear and fossil evidence complete, without admitting that the question of their life succession with us must be determined by them. In Cornwall it is doubtful if we have as yet any well-developed Upper Devonian fauna, or such as is so well exhibited and clearly defined north of Southmolton and Bideford, at Baggy, Marwood, Pilton, and Croyde.

The Tintagel and Delabole slates, and their associated greenstones, are without doubt of Upper Devonian age, but their history has not yet been worked out; indeed, as before stated, we really know little of the North Cornish rocks and their associated fossils, until, travelling south-westward, we reach the south coast between Hope's Nose, in South Devon, and Gorran Haven, in Cornwall, when the Lower and Middle Devonian beds are characteristically developed.

The following table will enable us to understand the relation of the Old Red Sandstone of Scotland, Wales, and Herefordshire, to the Devonian series of Cornwall, North Devon, and South Devon, and also to the equivalent deposits of the Rhenish, Belgian, and French areas; and although Cornwall contains (*so far as we yet know*) fewer species than either North or South Devon, it seems to be, from the groups represented, only a question of research; for only three groups are unrepresented in Cornwall; viz., the Plantæ, Annulosa, and Pteropoda. Nevertheless, as a whole, it is richer in species than either of the three Continental Devonian deposits.

It is a singular and perhaps remarkable fact that not more than two or three species of fish are known in the Devonian rocks of Cornwall, and in South Devon only three; viz., *Phyllolepis con-*

centricus, an *Onchus*, and a species of *Holoptychius*, whereas in the three divisions of the Old Red Sandstones of Scotland no less than 113 species are known, in rocks probably deposited at the same time but in different areas, and now believed to be of fresh-water origin. The Devonian proper, it will be remembered, are, on the contrary, marine in their origin. The fresh-water derivation of the Old Red Sandstone in the British Islands is borne out by the fact that there are no marine species of any kind in these rocks. The crustacea belong to the Merostomata (*Eurypteridæ* and *Pterygotidæ*), and the only known shell is a unio.

It therefore still remains a fact that in the Old Red Sandstone there are no true marine forms, but in the Devonian rocks of the British Islands there are no less than 390 marine species. The preceding Silurian fauna numbers some 1200 species. Not more than three pass from that formation into the Devonian, and 56 of the 390 Devonian forms pass to the Carboniferous in Britain, thus clearly showing the intermediate importance of the Devonian system through its organic remains alone.

To the Devonian series we may therefore assign 334 species, after eliminating the 56 forms passing to the Carboniferous. We must therefore maintain that the peculiar Devonian fauna has a most definite value, because its stratigraphical place is determined, and the geological age of the species is proved by the stratigraphical position of the beds containing them.

Dr. Holl, F.G.S., in his paper upon the "Older Rocks of South Devon and East Cornwall,"* enters into many particulars relative to the Devonian rocks of Trevalga, Delabole, Padstow, and the west coast, and clearly shows that the Middle Devonian group is represented as far south as Padstow. Dr. Holl concludes that neither the highest nor lowest of the Devonian system (as seen in North Devon), occurs on the south side of the Bude culm trough, and that the slate rocks which pass under the Carboniferous series on the north, are not the same as those that rise from beneath them on the south.

Mr. T. Weaver,† in 1838, showed that the culm measures of

* "Quar. Jour. Geo. Soc.," vol. xxiv., pp. 400, 454.

† "Geological Relations of North Devon." "Proc. Geo. Soc.," vol. ii., p. 589.

the great trough did not rest conformably upon the underlying Devonian rocks, which he recognized as forming a *peculiar transition group*, and Dr. Holl inclines to the same basis, believing that the "culm rocks were laid down on the denuded surface of the older or Devonian rocks." This break in the sequence (if it be so) demands a lapse of time to be accounted for, and still more strengthens the opinion held as to the age and position of the Devonian system in Devonshire and Cornwall. Again, we have reason to believe that the series has an unconformable base upon the Lower Silurian rocks of the south of Cornwall and South Devon.

It is now time that some Cornish geologist should, through the fine materials in our museum, co-ordinate the Cornish beds with those of North Devon and the Continent. Our fossils are mostly named, the localities can be relied upon, and no finer specimens can be desired for reference.

A short time ago I received the Report, in French, of a new Geographical Society (Société Khédiviale), founded at Cairo, and was refreshed to find that the dwellers on the banks of the Nile are recognizing the importance of man's exploring "every corner of the planet which he inhabits." "Geography," says the presidential address, "does not limit herself to describing the external form of the earth, the outer covering which it has assumed, she tries to show the connection of the causes of which that form is only the expression. But this highest aim of modern geography is scarcely appreciated hitherto: it will remain a task for generations to come."

What the Egyptians are invited to attempt, our Society hopes to get effected for this corner of Great Britain. The undertaking is not an easy one; for it involves a wide acquaintance with the literature of the subject, and with the structure of other lands. But for the credit of the county, let us trust that the work as a labour of love will not be long neglected, and that the unravelling of the structure of our strata may not pass into a stranger's hand.

NUMBER OF GENERA AND SPECIES IN THE *OLD RED SANDSTONE* AND *DEVONIAN* SERIES OF GREAT BRITAIN, AND THE NUMBER OF SPECIES IN THE DEVONIAN ROCKS OF RHENISH PRUSSIA, BELGIUM, AND FRANCE.

	Old Red Sandstone.		British Devonian.					Foreign Devonian.		
	Genera.	Species.	Genera.	Species.	Cornwl.	S. Dev.	N. Dev.	Rhenish.	Belgian.	French.
Plantæ	12	13	4	4	..	..	3	..	..	..
Amorphozoa	..	..	4	9	2	9	1	2	1	..
Cœlenterata	..	..	25	53	7	51	19	18	17	14
Echinodermata	..	..	10	21	2	12	11	4	5	..
Annulosa	1	1	2	2	..	1	2	1	..	..
Crustacea	7	21	6	13	4	12	3	9	4	2
Polyzoa	..	..	8	13	4	8	8	4	2	2
Brachiopoda	..	..	25	99	31	67	48	41	44	28
Monomyaria—bivalves	..	..	3	22	9	9	10	3	2	..
Dimyaria "	1	1	18	36	8	11	22	5	4	3
Gasteropoda	..	..	12	46	9	37	10	13	11	..
Nucleobranchiata	..	..	3	9	2	3	6	..	3	..
Pteropoda	..	..	1	1	..	..	..	..	..	..
Cephalopoda	..	..	6	52	26	26	9	4	7	1
Pisces	43	113	3	3	3	..	1	..	..	..
	64	149	130	383 7*	107	246	153	104	100	50
				390						

* Additional Species.

REPORT OF THE COUNCIL.

THE success which has attended the efforts of the Society during the past twelve months has been no exception to that of recent years; and in presenting their Sixty-fourth Annual Report, the Council have once more the pleasant duty of recording progress, and of congratulating the Members thereon.

The fossil collection has been thoroughly rearranged by Mr. Etheridge, of the Museum of Practical Geology, who considers our local collection important, and a credit to the Society. By study of the carefully-labelled specimens—many of them unique and valuable—much may be learnt; but for more complete educational purposes, Mr. Etheridge suggests the desirability of our possessing a typical series, a series which, should the matter be soon favourably decided, he would himself select and arrange. This collection would cost about £50, to which must be added little less than £30 for a suitable wall-case in which to display it. The Council hope to be able to secure this valuable addition to our Museum out of the ordinary funds of the Society, and at least one handsome donation has been received, from a new member, Mr. Code, of Marazion, towards the object in view, thus raising a hope that Mr. Etheridge's suggestion may at once be carried into effect. Your Council propose to take immediate action in the matter.

The large class-room was arranged for the accommodation of eighteen students, being fitted up with all that is necessary for the laboratory, shortly after the last Annual Meeting; and it is with much satisfaction that the Council allude to the very remarkable proficiency displayed by the pupils of your Assistant-Curator, Mr. Barnett.

The papers read last year, together with the Sixty-third Annual Report, have been printed and circulated among the Members, as well

as sent to numerous scientific bodies at home and abroad. There is an increased demand for the *Transactions* of the Society, and applications for their purchase or exchange, from our own country and from far distant lands, have been unusually numerous during the past twelve months.

Your Librarian will tell you that many valuable works have been added to our shelves.

The Report of your Curator, who regrets his inability to attend to-day, will more particularly detail what has been done in the Fossil Museum, and offers certain suggestions which will require careful consideration.

An unusually large number of visitors have examined our collections during the year, and not less than 850 have entered their names in the visitors' book.

The Council have to lament the removal by death from our Honorary List of two distinguished names, David Forbes, F.R.S., and Dr. Bryce. The Earl of St. Germans too, one of our Life Members, has but recently passed away. From our Ordinary List we have lost Mr. Giesler, who, residing at a distance, will be best remembered by our oldest Members, as well as three others whom we have been accustomed to meet at these annual gatherings; viz., Mr. John Symons, Mr. Robert Were Fox, and Mr. John Dennis. Especially do we regret the death of Mr. Fox, the last of the original Members of the Society, a frequent and valued contributor to its *Transactions*, who never ceased to take an interest in its welfare. He died on the 25th of July last, in the 89th year of his age.

As an Honorary Member of this Society, the Council recommend the election of Mr. Thomas Sopwith, F.R.S., and, as Ordinary Members, Mr. Thos. Algernon Dorrien-Smith, Dr. Hunter, Mr. Leonard Courtney, M.P., and the Rev. Thomas Thiselton Dyer.

GEORGE BOWN MILLETT.

Penzance, Nov. 2nd, 1877.

LIBRARIAN'S REPORT.

PRESENTATIONS.

1. By JAMES CROLL, F.R.S.—
   On the Mechanics of Glaciers.
   On the Transformation of Gravitation of Glaciers.
2. By B. STUDER—
   Studien der Petrographie und Stratigraphie der Schweiz und ihrer Umgebungen.
   Carte Géologique de la Suisse, Escher von der Linth, and five pamphlets.
3. By J. H. COLLINS, F.G.S.—
   Note on the occurrence of Achroite at Rock Hill, St. Austell, and on the Black Tourmaline of the same district.
4. By JOSEPH PRESTWICH, M.A., F.R.S.—
   On the Mineral Water Discovered in Sinking the Artesian Well at St. Clements, Oxford.
5. By CLEMENT LE NEVE FOSTER, B.A., D.Sc., F.G.S.—
   Report on the Inspection of Metalliferous Mines in Cornwall, Devon, Dorset, and part of Somersetshire, for the year ending 31st December, 1876.
6. By Messrs. W. H. HUDDLESTON, M.A., F.G.S., and J. FRAS. WALKER, M.A., F.G.S.—
   On the Distribution of the Brachiopoda in the Oolitic strata of Yorkshire.
7. By M. DELESSE—
   Sur les gisements de chaux phosphaté de l'Estremadura.
8. By WARINGTON W. SMYTH, M.A., F.R.S.—
   Physical Phenomena connected with the Mines of Devon and Cornwall.

9. By C. Le Neve Foster—
   A. On some New Mineral Localities in Devon and Cornwall.
   B. A Defence of Turner's Method of Detecting Boracic Acid.

10. By Messrs. C. Le Neve Foster, and Walter Pike—
   Suggestions for the Formation of a Miners' Permanent Club and Relief Society for Devon and Cornwall.

REPORTS, TRANSACTIONS, PROCEEDINGS, OF

1. The Mining Surveyors and Registrars of Victoria, Australia.
2. Devonshire Association.
3. Manchester Geological Society.
4. Royal Cornwall Polytechnic Society.
5. Royal Society.
6. Plymouth Institution.
7. American Philosophical Society.
8. Palæontographical Society.
9. Literary and Philosophical Society.
10. Geological Society.
11. Geological Association.
12. Royal Society of Edinburgh.
13. Royal Society of Victoria.
14. Royal Institution of Cornwall.
15. National Museum of Rio de Janeiro.
16. Smithsonian Journal.
17. Geological Survey of India.
18. United States Geological Survey of the Territories.
19. United States Survey of Wyoming.
20. Leicester Town Museum.
21. American Academy of Arts and Sciences.
22. United States Entomological Commission.
23. Chief Inspector of Mines, Victoria.
24. Società Toscana di Scienze Naturali.

MAGAZINES, JOURNALS, &c.

1. London, Edinburgh, and Dublin.
2. Quarterly Journal of Geological Society.
3. Annales des Mines.

MISCELLANEOUS.

Mineral Map and General Statistics of New South Wales.
La Libraire Francaise en 1876. Catalogue.

BOOKS PURCHASED.

1. Field Geology. By W. H. Penning, F.G.S.
2. Observations on the Rich Parts of the Lodes of Cornwall. By M. L. Moissenet, translated by J. H. Collins, F.G.S.

CHARLES C. ROSS, *Librarian.*

November 2nd, 1877.

CURATOR'S REPORT.

I REGRET to announce that somewhat fewer donations than usual have been made to the Museum during the past year, a falling off which I trust is only temporary.

I think it advisable to urge upon the Society more strongly than ever the necessity of having a properly qualified person to devote at least six or seven hours a week to the Collections. I regret that the spare time at my disposal renders it impossible for me to discharge the duties of my office in a way satisfactory to myself; and my valued assistant, Mr. Barnett, has been prevented by various business engagements from giving frequent attendance at the Museum.

In order that the work may be properly carried out, I consider it is requisite that the Assistant-Curator should attend regularly; but such service cannot be expected unless he is paid. The feasibility of taking this important step will have to form a subject of consideration for the Council, and especially for the Treasurer. There is ample work for some time to come in cataloguing the fossils, now that a large part of them have been named by a competent palæontologist. Again, it is very desirable that a printed catalogue of the Collections should be prepared and brought out; and I fear that it will be impossible to get this work carried out until we secure the regular attendance of a paid assistant.

It is a great satisfaction to be able to state that the fossil collections have been examined and set in order by so eminent an authority as Mr. R. Etheridge, F.R.S. He has devoted ten days' labour to those objects, and the opinion which he has formed of the relative value of the different portions of the Collection will be best given in his own words.

GENERAL COLLECTION OF FOSSILS.

"This is a very small and by no means a representative Collection, so far as the palæontology of Britain is concerned; indeed, it is of little or no value in an educational point of view, none of the several formations being even tolerably illustrated, except, perhaps, the *plantæ* of the coal measures (but these are German), and a few Silurian and Devonian species, also foreign. These two divisions and groups occupy the two lowermost shelves in the wall-case. The third shelf contains a series of Jurassic and Cretaceous fossils, which are by no means typical or educational, *many* being foreign, and quite accidental forms, not being in any way instructive. Those species belonging to the Inferior Oolite are mostly foreign, and I question their *stratigraphical* value entirely. The few Cretaceous species are really valueless too. These *secondary fossils* occupy two shelves. The Palæozoic, as before named, also occupy two shelves. There are no Gault species; no Neocomian; few Portland; few Kimmeridge; no Coral Rag whatever; few or no Lias; and scarcely any of the Ammonites of the Lias, or the Oolites, and Cretaceous beds. The upper shelf *should* contain Tertiary fossils; but there are literally none of use—*one* species only from the Crag, and only fifteen or sixteen from the Tertiaries, out of nearly 3,000 species.

"I regard this wall-case as being of little or no value as illustrating British palæontology or geology, on account of the unconnected state of the series, and the many wants in the groups. Many hundred typical specimens are wanted to enable students to at all prepare themselves to understand the ordinary and typical fossils of the British strata. I strongly recommend that a characteristic or typical series of *British* species of fossils be added to your Collection, thus making your series educational and valuable for students and reference.

DEVONIAN COLLECTION.

"This portion of your collection is perhaps unrivalled as a series of local organic remains. It occupies five cases (table cases), and

is so far classified as to be of much value to the student of Devonian geology. A large quantity of Devonian material yet remains unnamed and really unarranged; indeed, it will take many weeks to go through the Devonian fossils properly. Doubtless many new forms occur in the collection. Duplicates are very numerous. I have placed everything out, and named a large series; but much remains yet to be done. I have also corrected the nomenclature so far as time would allow me.

"Relative to the characteristic or typical collection, which I feel sure your Society should purchase and exhibit, I do not think it would exceed £40 or £50 to purchase a carefully-selected series of typical fossils illustrating the general palæontology (invertebrate) of the British Islands. The present advanced state of geological knowledge, and your position as a Society and educational body, demands some addition to your present general collection; or else *do away* with the few already in the collection, but of no value for teaching purposes."

I append a list of donations to the Museum in the past year.

DONATIONS.

Granular stalagmite, from Kent's Cavern. *Presented by J. J. Rogers, Esq.*

Pitchblende, from East Pool Mine. *Presented by Capt. John Maynard.*

Two specimens of Barytes, from Teign Valley Mine, Bridford, Devon. *Presented by Capt. F. Rowe.*

Crystallized white arsenic. *Presented by the Rev. Wm. Borlase, of Zennor.*

Calcareous deposits of a petrifying spring, Bosahan, Helford River; and water-worn pebble from conglomerate, near Nare Point, Helford River. *Presented by the Rev. Wm. Rogers, Rector of Mawnan.*

Sand-worn stone, from New Zealand. *Presented by J. Enys, Esq., F.G.S.*

Piece of Egyptian Syenite, from the base of a column at the Cæsareum, Alexandria. *Presented by Charles Fox, Esq.*

Silicate of Nickel (Noumeite), from Ballad, New Caledonia. *Presented by Dr. Montgomery.*

Pieces of Granite, exhibiting faults, from Quarry on the west side of Tregonning Hill. *Presented by Mr. Philip Floyd, of St. Hilary.*

A Quartz Conglomerate, from Polcrebo Downs, Crowan. *Presented by Mr. Wm. Paul, of Illogan.*

PURCHASES.

NAME.	LOCALITY.
Isopyre . . .	Wheal Margery, Lelant.
Phacolite . . .	Richmond, U.S.A.

CLEMENT LE NEVE FOSTER,

Curator.

December, 1877.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

2nd NOVEMBER, 1877.

1. A New Tin Scheme. By Wm. C. Borlase, M.A., F.S.A.
2. On the Trelissick Elvan, with a proposed Classification of the Cornish Elvans. By J. H. Collins, F.G.S.

TREASURER'S STATEMENT, 1876–7.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* *Cr.*

RECEIPTS.

	£	s.	d.
To Balance	23	6	9
„ Donation per H. R. H. The Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears	85	0	0
„ Sale of Vols. 7 and 8 of Transactions	5	0	0
„ Rent, by way of acknowledgment, per Penzance Public Buildings Company	0	10	0
„ Donation per T. Code, Esq.	10	0	0
	£143	16	9

EXPENDITURE.

				£	s.	d.
By Rates and Taxes				0	8	0
„ Housekeeper				6	10	0
„ Insurance				2	12	9
„ Advertising				2	18	8
„ Expenses per Secretary and Treasurer				5	17	10
„ Subscription to Palæontographical Society				1	1	0
„ Prize Essay				5	0	0
„ Grant in aid of Mr. Barnett's Class				5	0	0
„ Professor Etheridge arranging Fossils	10	10	0			
„ Bills per do.	3	18	8	14	8	8
„ Printing, Books, Stationery, &c.				24	13	4
„ Sundry Bills				10	6	1
„ Deposited at Interest				10	0	0
„ Repairs				15	4	0
„ Balance				39	16	5
				£143	16	9

W. BOLITHO, Jun.,
Treasurer.

2nd November, 1877.

ON THE TRELISSICK ELVAN,

WITH A PROPOSED CLASSIFICATION OF THE CORNISH ELVANS.

By J. H. Collins, F.G.S.

I. THE TRELISSICK ELVAN.

On the western shore of the Truro river, between Malpas and Trelissick Point, there are several good exposures of an intrusive rock, the mineralogical composition of which differs very materially from that of the majority of the Cornish elvans; and although it has been briefly noticed by Mr. A. K. Barnett in his "Remarks on the Cornish Elvans,"* and by Mr. J. A. Phillips,† I have thought that a detailed description might be interesting to the members of this Society.

The killas of the country between Truro and Falmouth dips generally to the south of east, at an angle averaging perhaps about 20° to 25°. The elvan in question, part of which is outlined on the Survey Maps, but not coloured as such, runs nearly north and south in a somewhat tortuous line, and underlies to the eastward at an angle approximating

---

* *Report of Miners' Association.* 1873.

† *Quarterly Journal of the Geological Society,* No. 143.

that of the killas. Mr. Barnett has indeed stated that it is *conformable* with the slate, and this suggested to me the idea that it was merely an altered bed; but, on carefully examining the sections, I soon found that it was intrusive. Commencing at Trelissick Point it crosses Channel Creek, where it is visible on both shores, and continuing in a direction somewhat east of north, through Trelissick, past Roundwood, near which place it is seen in a little creek, it goes on to Halwyn Farm; soon after which it divides, one branch passing across the river to Victoria Point, near Malpas, while the main mass, trending somewhat to the west, appears in a field above Lamb Creek, and also on the shore of the creek. This course is about three miles, and nothing more is marked on the Survey Maps; but southward it seems to be nearly in line with the trappean rocks of Beacon Hill, a little to the west of Falmouth; and Mr. T. Clark, of Truro, informs me that a very similar rock has been seen near Eddless, one mile north of Truro, and again at Cargoll. Mr. Barnett, in his paper before mentioned, states that rocks of a similar character occur at Gloweth, Liskis, Short Lanes End, and Gwarnick, and again at Fiddler's Green. If these should prove hereafter to be ramifications of the same dyke, as, after going over the ground, I think is highly probable, we have a total length of over twelve miles. On the south side of Channel Creek, the killas is seen dipping at a greater angle than the elvan. The elvan is about 17° from the horizontal, and about 30 feet thick, with a some-

what concretionary structure. The killas is of a grey colour, and dips perhaps 25° from the horizontal.

On the north side of the creek the elvan dips about the same; but the killas here is more nearly horizontal than it, so that here also it is clearly intrusive.

In the creek to the north of Roundwood the killas dips about 43° S.S.E., while the dip of the elvan is about 25°. Above the elvan the killas is contorted, but the elvan is much smaller, not more than about 12 feet thick.

Under the cliff at Victoria Point two distinct branches are seen at low-water, two feet and eight feet respectively in thickness, with about two feet of killas between. Here there is an abrupt contortion of the strata, and the elvan seems to have been contorted with the slate. Several small branches were formerly to be seen in the quarry above Victoria Point, but these are now almost entirely obscured by rubbish.

The main mass of the elvan, as I have already said, has a more westerly course than the branches just mentioned. It spreads itself out on the northern shore. The portions near the surface are much decomposed. The colour varies from yellow, in the softer decomposed portions, to chocolate-brown, with a purplish tinge in the harder parts. The soft portions consist chiefly of brownish-yellow mica, which in some places is rather green. Many particles of a peculiar quartz, much resembling corundum in lustre, occur interspersed throughout the rock. These vary from less than a hundredth of an inch to a foot in

diameter, and are often rudely spherical, with a coating of flakes of mica. Distinct crystals of felspar are rarely to be seen except in microscopic sections. In general the rock appears to be composed of brown mica, enclosing the quartz grains and lumps just mentioned; but by the aid of the microscope these are seen to be imbedded in a quartzo-felspathic base. Figs. 1, 2, 3 are drawn from microscopic sections, prepared by myself. Fig. 1 is a section showing the general appearance under a 2″ objective, with one of the quartz granules near the centre. In fig. 2 we have a portion of the same slide as seen under the 1″ power. Here too a quartz granule forms the centre, which is surrounded by mica crystals as stated. In fig. 3 we have a small portion of the same slide under the ¼″ power, and in polarized light, with crossed prisms. The form of the mica crystals is here shown very plainly. The groundwork shows the intimate mixture of quartz and felspar spoken of by Mr. J. A. Phillips, and in addition we have the small acicular crystals, which I believe are also felspar, but too thin to give colours with polarized light. The mica is strongly dichroic, changing colour very distinctly when the polarizer only is used and revolved. My observations confirm Mr. Phillips's statement that the quartz contains gas-cavities, but no fluid-cavities; in this differing greatly from all the ordinary Cornish elvans, in which fluid cavities are extremely common.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

W. Brewster & Son, Lith. Edinr.

II. A PROPOSED CLASSIFICATION OF THE CORNISH ELVANS.

In speaking of this rock as an elvan, I have had in mind the mineralogical composition—quartz, felspar (orthoclase), and mica (the latter of some species as yet undetermined), and its distinctly intrusive character—but it differs very greatly from what is generally understood by the term elvan. I have here on the table three distinct types of such intrusive rocks, and they differ so widely one from another that I think they should have distinct specific names. The typical elvan is illustrated by specimen No. 1 and figure 4. Figure 4 represents, by the aid of polarized light, the indistinct quartzo-felspathic base, the embedded crystals of quartz containing fluid cavities, and of orthoclase felspar, which is generally somewhat decomposed, with a few crystals and fragments of mica. The crystals of quartz are generally somewhat rounded, and sometimes apparently eaten into or corroded away by the felspathic base, as shown by Mr. Phillips's paper, "On the Rocks of the Mining Districts of Cornwall and Devon," before mentioned. To this kind of elvan I think the well-known term *elvanyte* should be restricted.

The second type is represented by figures 5, 6, 7, and specimen No. 2. Figure 5 shows the appearance of a thin slice under the 1″ power; figure 6 under the $\frac{1}{4}''$, and figure 7 under a good $\frac{1}{5}''$. Embedded crystals of quartz and mica are extremely rare, and I have never found crystals of felspar

visible to the naked eye. The whole rock appears to be made up of needles, or fibrous bundles of felspar, with a few minute grains of quartz. Very little colour is seen when polarized light is used. Elvans of this character occur at St. Dennis Down, St. Stephens, Goonbarrow, and other places in the decomposed granite near St. Austell. I have found similar elvans in the decomposed Bodmin granite, but never in hard granite. A very similar elvan was however formerly worked at Newham, near Truro, in the killas, and a large portion of that city is built of stone obtained from this quarry. This is the stone which travellers have often called freestone, and mistaken for oolite. As a very fine elvan of this character on Trelaver Downs furnished me with my first microscopic slides and chemical analyses of this rock, I would venture to suggest for it the name of *trelaveryte.*

The third type is the rock from Trelissick, already described somewhat in detail. For this I propose the name *trelissickyte*, as I cannot find that a similar rock has ever been named.

The definitions of these terms would then run much as follows:

Elvan. A term applied to dykes of a quartzo-felspathic character, often porphyritic; the base or "ground-mass," crypto-crystalline or granular. Of this rock there are three varieties—

Elvanyte, containing numerous crystals of quartz and orthoclase, with some mica; the quartz often rounded, and containing fluid cavities.

Trelaveryte. Distinct crystals of quartz, felspar, or mica, very rare or altogether absent.

Trelissickyte contains many granules of quartz (not crystals), and a large number of mica crystals; distinct crystals of felspar rare or absent.

I append a series of analyses illustrating the chemical composition of these related rocks, together with that of Cornish granite.

	Granite.		Elvanyte.		Trelaveryte.			Trelissickyte.	
	1	2	3	4	5	6	7	8	9
Water { hygro.	·34	·87	·11	·26	·43	·29	·24	·34	·61
Water { comb.	·89	tr.	·49	2·03	1·27	3·69	2·04	6·11	6·32
Silica	74·69	74·54	72·51	72·82	71·46	72·43	72·88	47·35	48·01
Alumina ..	16·21	14·86	13·31	15·12	15·38	18·08	14·47	20·00	19·20
Ferrous Oxide	1·16	·23	3·87	tr.	2·27	....	....	1·60	....
Ferric Oxide ..	tr.	2·53	tr.	1·75	·30	2·20	2·45	3·10	4·82
Manganous Ox.	·58	tr.	·62	tr.	tr.	tr.	·82	tr.	tr.
Lime	·28	·29	·60	·52	·47	tr.	·10	4·72	4·30
Magnesia ..	·48	tr.	1·52	1·06	·22	tr.	tr.	6·12	5·80
Potash ..	3·64	3.73	6.65	6·25	5·51	} 4·12	7·15 {	6·29	} 10·12
Soda	1·18	3.49	·43	·51	2·79			3·58	
Lithia ..	·10	tr.	....	....	....	tr.	tr.	....	tr.
Fluorine ..	....	....	tr.	....	....	tr.	tr.	tr.	tr.
	99·55	100·54	100·11	100·32	100·10	100·81	100·15	99·81	99·18
Sp. Gr. ..	2·64	2·66	2·62	2·64	2·65	2·45	....	2·70	2·72

Of these analyses Nos. 6, 7, and 9 are my own; the rest are by Mr. J. A. Phillips.*

No. 1 is granite from Carn Brea; 2 is granite from Botallack; 3 is the well-known porphyritic elvan from Pra Sands, near Sydney Cove, which contains pinite;

* *Quarterly Journal of the Geological Society*, No. 143.

4 is a very similar elvan from Tregoning Hill in Breage; 5 is from Mellanear, near Hayle; 6 from Foxhole in St. Stephens; 7 from Newham, near Truro; and 8 and 9 from Trelissick Creek. It will be seen that the differences in ultimate composition between granite, elvanyte, and trelaveryte are very small, notwithstanding the great differences in appearance. In trelissickyte however we have a very marked difference, the silica decreasing from over 70 per cent. to less than 48, the lime and magnesia increasing from 1 or 2 per cent. to about 11. The alkalies also are rather more in quantity, and the combined water is increased to over 6 per cent., although the rock shows less sign of change under the microscope than any of the others.

That the composition of the last-named rock should differ from all the others is quite what might be expected from the difference in its direction, just as in general the filling of a cross-course differs from that of a right lode. The trelissickyte is a north and south elvan, while all the others are more nearly east and west. It is reasonable therefore to suppose that it is of a different age, and has come from a different source. I am inclined to believe that it is rather volcanic in its origin than plutonic, probably older than the great granitic upheavals of Cornwall, and connected with the trappean rocks of Beacon Hill, near Falmouth, and of Veryan, the serpentine of Duporth, and perhaps with the greenstones of the north coast between Padstow and Tintagel.

A NEW "TIN SCHEME;"

OR,

NOTES ON MANUFACTURED ARTICLES OF PURE TIN.

By W. Copeland Borlase, F.S.A.

Mr. W. C. Borlase read a paper entitled "A New 'Tin Scheme.'" The subject was purposely treated in a popular or colloquial form, and by way of introduction to it, the author exhibited from the Museum the Treloy pan, found in an ancient tin-ground near St. Columb Minor. It is made of the purest tin, but its date is uncertain. He also exhibited a drawing of the curious Halvasick cup found in the parish of St. Stephen's about the year 1793. It was also found in a stream-work, and is made of pure metallic tin. In addition to these specimens of ancient Cornish pure tin-ware, there was, he said, in the Museum at Truro the vessel found in the Carnon stream-works.

The occurrence of these objects in Cornwall was, sufficient, he proceeded, to show that there was a time—no matter when—at which tin was used in this country in an almost unalloyed state, for the manufacture of articles for use and beauty. At some remote period in the annals of ancient Britain tin coins were actually the means of a currency, one specimen of which from his own collection he had

with him. In other countries this metal had been put to a similar use. He produced a piece of money, made of pure tin, from Singapore, and used for trading purposes by the natives in the interior. Indeed, in the East especially, from time immemorial, tin in its pure state had been turned by man to good account, and made to do him good service. He showed a little *seki* (that is, native beer) jug, of no recent make, which he had bought a few years since in the interior of Japan, a country where tin is rare. Gradually, however, as in the case of the sea-shell cited by Emerson, "that which Nature at one time provides for use, she afterwards turns to ornament." Through the kindness of Mrs. Warington Smyth (whose earnest solicitude for the welfare of the county and the tinners in it, especially in the midst of their present distress, had prompted him, a few days before, to take in hand this merely tentative paper), he was permitted to call their attention to the elegant articles before him, all of pure tin, from British Burmah. The place of their production was Moulmein, and the producers were Chinamen. Failing to get a sufficient price for their product regarded as a useful commodity, their artificers were but following the rules of Nature in trying what it would bring as an ornament. Mr. B. H. Baden-Powell, who sent them to England, states that the tin of which they are composed is raised from stream-works in Tennasserim. Like the Treloy vessel, therefore, they too are made of stream-tin, *and without alloy of any kind.*

"Now," continued Mr. Borlase, "in looking at

objects such as these, it naturally occurs to us—If these things can be produced and made saleable at a fair profit in the Malay straits, why should not a similar industry take its rise amongst us at home? The Tennasserim stream-works, Mr. Baden-Powell tells us, were not paying costs; thereupon it was that the natives (that astute, though heathen, Chinee) turned their attention to anything, however small, which might create a greater demand. The Cornish miners are in much the same condition. What then should hinder us from owning that the time has come, not for the ornamental to take the place of the useful—for that would be absurd—but for it to come to its assistance when times are bad? It is probable that the adoption of tin for carrying pure water through pipes, so much recommended by scientists of late, may help just a little. Musicians, too, have found out that organ pipes are best when made of purest tin. This fact, if universally acknowledged, might help still more. The objection to making tea-chests, &c., of pure tin—namely, that being quickly worn out, the metal would be reconverted, and so in the end hinder the demand—even if it be a valid objection at all, would not hold in the case of which I am speaking, since the articles would be solid and lasting. Might not a new industry, then, be created which would show that articles such as dinner-services, including hot-water dishes, covers, etc., etc., biscuit-boxes, and ornamental objects such as those exhibited, could be produced with profit? Would not many a Cornish housewife fill her dresser with tin-plates if

she found them clean and bright, serviceable and cheap—not only for the name of the thing—as the lord's, or the agent's wife, or the tinner's daughter—but for the good of her native county? I think she would do so. Would not a pure tin dish-cover or biscuit-box, which pretends to be nothing more than it is, be much more in demand than a plated article, which would be silver if it could, and always gets found out as it grows older? Would not visitors to our watering-places buy a bracelet, if made of solid Cornish tin, burnished and chased, warranted unmixed, save with some slight alloy, and if raised from the mines in the neighbourhood? Who knows, a shop in Regent-street would follow, like that for the sale of aluminium; for the articles produced by the Chinese have this advantage, that they neither tarnish nor turn dull, but retain the brightness of silver, whether burnished or frosted. At all events, however infinitesimal it might be in proportion to the quantity brought into the market, there would be a *slightly* greater demand for tin, and it might be reasonably hoped, as a consequence, a slightly better price.

"But I think I hear some doubters saying, 'Who 'll care to have anything made of tin in these days? It is true our grandmothers had their block-tin saucepans and kettles, and would use no others; but the very idea of tin has got to be so indissolubly connected with the modern tin-kettle, that the prejudice against the metal will be too strong for you.' But I need not remind my present audience that a tin-kettle is

no more tin than is a gilded Easter egg, such as one sees abroad, made of solid gold. Tin in itself is a true and beautiful metal, capable of receiving so high a polish as to make it scarcely distinguishable from silver. In common, however, with the more precious metals, it is not hard enough in itself, but must have an alloy (antimony or arsenic, or I know not what else), the proportion in which such an alloy would be used depending on the amount of hardness required in the article to be produced.

"You will naturally ask whether such a simple experiment has never been tried as that of making useful articles of pure tin with a view of bettering the tin-trade. I am pleased to say that not only has it been tried, but that it was tried within seven miles of Penzance by the father of a member of our Society, present here to-day. In the year 1843 when the price of tin was very low, the late Mr. Stephen Harvey James, of Botallack, in connection with the late Mr. Richard Davey, gave instructions to Messrs. Dixon and Co., of Sheffield, to turn out for them a dinner-service of pure tin, the exact words of the order being, 'As full of tin as possible consistently with hardness.' The object with which the order was given was well worthy of that patriotic and enterprising spirit which characterized the generation in which those gentlemen lived, and, as such, it should be recorded. It was to induce mine agents and others to follow the example they set them, and so to stimulate the demand for tin. The dinner-service, of which the present Mr. Stephen Harvey James lent

some specimens for exhibition, consists of nine dozen plates, dishes and hot-water dishes of all kinds to match, covers, cruet-sets, and all complete. The whole of this large service cost less than £50—a fact which shows that if, in the absence of any definite tin-ware manufacture, articles could be turned out at so low a price, upon the establishment of such a branch of industry, they would, relatively to porcelain and crockery in the case of dinner-services, be extremely cheap. The plates have been in pretty constant wear ever since they were obtained, thirty-four years ago. They are not bulged or damaged, and they are not so deeply scratched as silver plate would be after a like amount of use. The alloy, in this case, was antimony. Mr. James reports of them that they are clean and sweet, and serviceable in every respect; and that they were undoubtedly a good investment—if only for the saving in crockery. Considering, too, how well they burnish, they may be considered to combine use with beauty."

Mr. Borlase concluded by remarking that his paper was only tentative. He had read it with the object of eliciting remarks; first of all from those who were conversant with the uses to which tin is, and can be, put; secondly, from those whose knowledge of chemistry might enable them to speak on the subject of the alloy; and thirdly, from any ladies or gentlemen who would be disposed to join him in procuring a service of tin. Some might say, "Your paper has very little to do with the subject of our meeting,—namely, Geology." If the President

thought so, he offered his humble apology; if anybody else thought so, he would remind him that Sir Henry De La Beche devotes a large chapter in his work to Economic Geology, and he did not know what could be regarded in Cornwall just now as more truly Economic Geology than the endeavour, which had been the object of his remarks, to obtain, in however small a degree, a better price for tin. "A hundred years ago 'Tin Schemes' were the order of the day. Some prospered; some did not; all were opposed; may this one have a better fate."